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1921.

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THE ASSOCIATION was organized in Boston, Mass., on June 21, 1882, with the object of providing its members with means of social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only TWENTY-SEVEN, its growth has prospered until now it includes the names of 900 men. Its membership is divided into two principal classes, viz.: MEMBERS and ASSOCIATES. Members are divided into two classes, viz.: RESIDENT and NON-RESIDENT, — the former comprising those residing within the limits of New England, while the latter class includes those residing elsewhere. The INITIATION fee for the former class is FIVE dollars; for the latter, THREE dollars. The annual dues for both classes of Active membership are SIX dollars. Associate membership is open to firms or agents of firms engaged in dealing in water-works supplies. The initiation fee for ASSOCIATE membership is TEN dollars, and the annual dues TWENTY dollars. This Association has six regular meetings each year, all of which, except the annual convention in September, are held at Boston.

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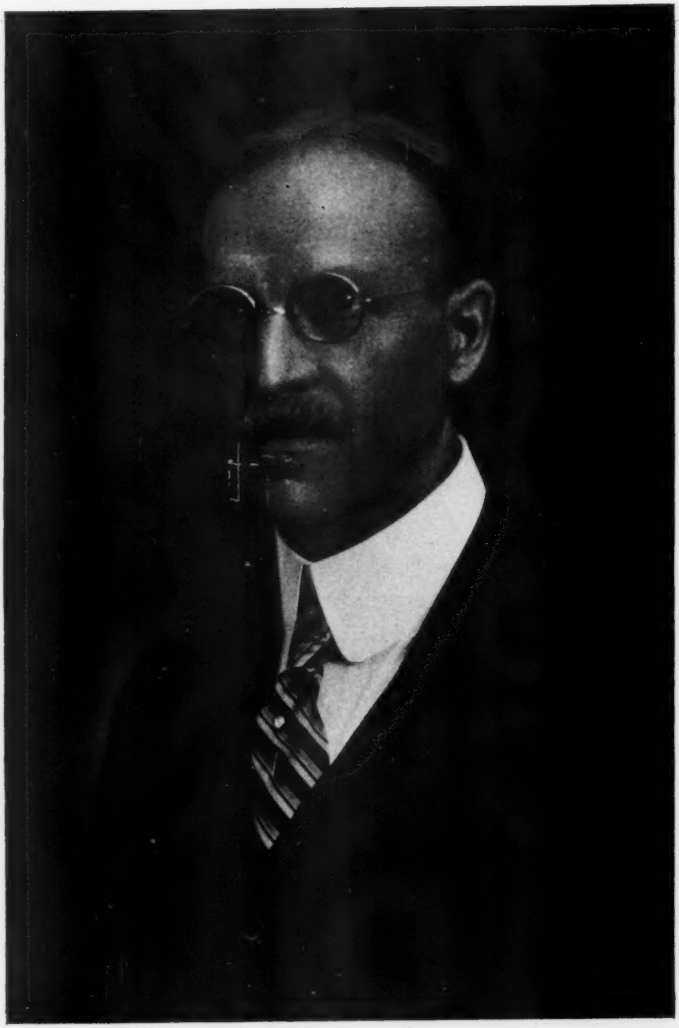

CHARLES W. SHERMAN,
President of New England Water Works Association,
1921.

New England Water Works Association

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This Association, as a body, is not responsible for the statements or opinions of any of its members.

STANDARD SCHEDULE FOR GRADING CITIES AND TOWNS OF THE UNITED STATES WITH REFERENCE TO THEIR FIRE DEFENSES AND PHYSICAL CONDITIONS.

JOHN S. CALDWELL.*

[*November 10, 1920.*]

This Schedule for Grading Cities and Towns of the United States with Reference to their Fire Defenses and Physical Conditions is not entirely new to members of this Association, as you have a special committee who have made progress reports from time to time, with especial reference to the water supply, and recommended certain changes which have been later incorporated into the Schedule, but I believe this is the first time that the Schedule has been presented to you in its entirety, and while your particular interest is naturally in the water-supply section, I think the other portions will prove to be interesting, as it will indicate the extent and degree of the so-called measuring stick which has been devised for determining the relative value of these various subjects.

I think that it will be time well spent if I go back and outline the causes which have led up to the need of this Schedule. In the past it had been deemed sufficient in the determining of insurance rates if a city or town had a water-works system, with hydrants in evidence; a fire department with apparatus, equipment, and men to handle same; a fire-alarm system, police department, building laws, etc.; but it had never been considered necessary to attempt to go into any great detail regarding the efficiency of such protection.

The natural result of such a procedure is apparent to all of you, namely, that inconsistencies existed which brought about rates which were not comparable with existing conditions, some being too high and others too low, and in general brought about a condition of affairs which was unsatisfactory to both the municipalities and the insurance interests.

In New England we realized the necessity for a change, and in 1913 put into effect our classified system of rating for dwelling-house property, which many of you are familiar with, whereby we graded the cities and

* Engineer, New England Insurance Exchange.

towns of New England on a 200-point basis, allotting the 200 points to a perfect or standard city or town according to the value of its water supply, fire department, fire-alarm system, ordinances, etc., the class being determined by certain limitations of the points allotted.

Meanwhile the National Board of Fire Underwriters were engaged in the compiling of a universal schedule which could be adopted all over the country, so that uniform results might be obtained in arriving at the value of the fire protection facilities of the various cities and towns. In the working out of this problem the advice of water-works officials, fire chiefs, insurance organizations, etc., was obtained, so that the final result might be said to represent the best opinion obtainable on the various subjects considered.

It is, of course, not to be claimed that the Schedule is perfect, as the practical application has shown that various changes have been necessary to meet certain local conditions; but we do feel that by the results so far obtained it is a forward step in the right direction and is a vast improvement over the old method.

It is this Schedule which was adopted by the National Board of Fire Underwriters in 1916, and by the New England Insurance Exchange in 1918, that I will attempt briefly to describe to you.

The grading schedule is based upon the plan of assigning to the various features of fire defense found in cities of the United States, points of deficiency depending upon the extent of variance from standards formulated from a study of conditions in more than 300 cities; the natural and structural conditions which increase the general hazard of cities, and the lack of laws or of their enforcement for the control of unsatisfactory conditions, are graded in the same way. The sum of the maximum points of deficiency totals 5 000 and is divided in accordance with the relative values of the features considered as given below.

RELATIVE VALUES.

			Points
Water supply	Engine stream basis		1 700
	Hose stream basis	2 000	
Fire Department	Engine stream basis		1 500
	Hose stream basis	1 200	
Fire alarm			550
Police			50
Building laws			200
Hazards			300
Structural conditions			700
			5 000

It is recognized that climatic conditions affect fire losses, by reason of the frequency of fires due to the heating hazard, by retarding the response of fire apparatus, by hampering effective fire fighting during cold weather and storms, by the increase in combustibility due to hot and dry weather,

and by the greater probability of fires spreading at time of high winds. These elements are to a greater or less degree common to the whole country, and therefore no deficiency is considered in the Schedule for normal climatic conditions. Some sections of the country, however, are subject to abnormal climatic conditions, and to cities in these sections a super-deficiency is applied, which I will describe later. This super-deficiency is to be added to the deficiency determined by the application of the Schedule proper.

A good water supply in connection with a poor fire department, or vice versa, is of less value than if both are good. In recognition of this, a modification of the better one of the two features is made in accordance with a plan which I will outline later to you.

In determining the points of deficiency to be applied to many of the items it appears reasonable to use a graduated scale of points, depending upon the per cent. of deficiency, with a lesser increment for the first 30 per cent. than for the remainder; that is, a deficiency of 10 per cent. in good or moderately good conditions has less actual effect than where conditions are poor. Such a scale has been prepared as shown below; either the full scale, a multiple or a fractional part thereof is used, depending upon the relative weight or importance of the item under consideration.

DEFICIENCY SCALE.

	0%.	10%.	20%.	30%.	40%.	50%.	60%.	70%.	80%.	90%.	100%.
0%	0	10	25	45	67	90	112	134	156	178	200
1%	1	12	27	47	70	92	114	136	158	180	
2%	2	13	29	50	72	94	116	138	160	182	
3%	3	15	31	52	74	97	119	141	163	185	
4%	4	16	33	54	76	99	121	143	165	187	
5%	5	18	35	57	79	101	123	145	167	189	
6%	6	19	37	59	81	103	125	147	169	191	
7%	7	21	39	61	83	105	127	149	171	194	
8%	8	22	41	63	85	108	130	152	174	196	
9%	9	24	43	65	88	110	132	154	176	198	

Where quantity or numbers cannot be used as the basis, the degree of deficiency is graded approximately as follows: Slight, 10 per cent.; moderate, 25 per cent.; considerable, 50 per cent.; serious, 75 per cent.; and total, 100 per cent. In considering the degree of such unreliability, the size of the community is considered; that is, conditions which in a city would be considered as serious would in a small town be only moderate or considerable because of the less general probability of a fire occurring.

It was very early recognized, after the Schedule had been applied to representative cities and towns, that the application of the items under fire department produced deficiency charges in small municipalities which were out of proportion with the actual experience found in such localities, due to the infrequency of fires, and it was decided to deduct from the total points of deficiency under fire department, 10 per cent. for each 1 000 population below 10 000, for certain items which were not as important in the small communities as in the larger cities.

After arriving at the total number of points of deficiency, the class of the city or town is determined from the following table.

CLASS DIVISION.

A first-class city or town is one receiving	0 to 500 points of deficiency.
A second-class city or town is one receiving	501 to 1 000 points of deficiency.
A third-class city or town is one receiving	1 001 to 1 500 points of deficiency.
A fourth-class city or town is one receiving	1 501 to 2 000 points of deficiency.
A fifth-class city or town is one receiving	2 001 to 2 500 points of deficiency.
A sixth-class city or town is one receiving	2 501 to 3 000 points of deficiency.
A seventh-class city or town is one receiving	3 001 to 3 500 points of deficiency.
An eighth-class city or town is one receiving	3 501 to 4 000 points of deficiency.
A ninth-class city or town is one receiving	4 001 to 4 500 points of deficiency.
A tenth-class city or town is one receiving	more than 4 500 points; or without a water supply and having a fire department grading tenth class; or with no fire protection.

I will now take up in detail the various subjects which are considered in the Schedule, relating to the water supply.

WATER SUPPLY.

Item.

1. Appointment of employees.
2. Efficiency of executive.
3. Records and plans.
4. Emergency repair provisions.
5. Receipt of alarms by department.
6. Normal adequacy of entire system.
7. Reliability of source of supply.
8. Sufficiency of reserve pump capacity.
9. Sufficiency of reserve boiler capacity.
10. Condition and arrangement of equipment.
11. Fuel supply or electric power.
12. Construction of pumping station.
13. Fire protection of pumping station.
14. Hazards of pumping station.
15. Exposures to pumping station.
16. Reliability of supply mains as affecting adequacy.
17. Reliability of installation of supply mains.
18. Completeness of arterial system.
19. Reliability of installation of mains.
20. Effect of small mains in the high-value district considered.
21. 4-in. mains in system.
22. Dead ends — 4- and 6-in. mains.
23. Completeness of gridiron of 6-in. mains.
24. Quality and condition of pipe.
25. Electrolysis.
26. Spacing of gate valves.
27. Condition of gate valves.
28. Distribution of hydrants in the high-value district considered.
29. Ditto in residential districts.
30. Condition of hydrants.
31. Size and design of hydrants.
32. Valves on hydrant branch.

In order to ensure efficient operation, employees on municipal systems should be under adequate civil service rules with tenure of office secure, except that, in cases of long tenure of office, an efficient organization would be considered the equivalent.

The chief executive — that is, the superintendent or chief engineer — should be competent and qualified by either experience or education, but preferably both, to efficiently fill the office.

Records and plans of the supply works, pumping stations, and distribution system, together with complete records of the operation of the system, should be in convenient form, safely filed, indexed, and kept up to date.

Emergency crews shall either be on duty at all times, or quickly available, with an emergency wagon loaded with the necessary tools. At least one responsible employee familiar with the system should respond to fire alarms in high-value districts and second alarms elsewhere.

Alarms of fire should sound in some quarters of the department, also in pumping stations where pressures are raised or pumps started to furnish fire service; telephone service to pumping station shall be considered as 25 per cent. of the total requirements, and, in the event of a lack of operating force on duty, this is considered as equivalent to deficient alarm service.

The item of adequacy of the entire system is one of the most important in the whole Schedule, as here one must determine as to whether the source, including the entire supply works, has the normal ability to maintain maximum consumption demands and fire flow.

In considering the deficiency under this item, the results obtained at fire-flow tests in the most favorable location in the high-value district is used as a basis in making calculations as to the probable deficiency under maximum consumption conditions, due allowance being made for any emergency supply. The extent of the deficiency of each part of the supply works must be considered and the percentage of the most serious used.

Cities are considered on an engine basis if the fire flow available at pressures permitting direct hydrant streams does not exceed actual engine capacity plus one third of the required fire flow, assumed to be as waste at time of fire, and the fire flow to be that obtained at the weakest part of the high-value district and at time of maximum consumption.

Allowance is also made on the ability of a system to deliver a fire supply on small fires direct without the use of engines, which increases the speed of operation of the fire department, even when full engine capacity is available.

Following is a table of required fire flow based on the population but modified by the individual characteristics of construction and hazards of the particular city or town under consideration. This table includes a probable loss from broken connections incidental to a large fire, and is based on the formula $G = 1020\sqrt{P(1-.01\sqrt{P})}$, where G = gallons per minute

and P = population in thousands; but in all cases consideration must be given to local conditions.

TABLE OF REQUIRED FIRE FLOW.

Population.	Required Fire Flow. Gallons per Minute for Average City.	Population.	Required Fire Flow. Gallons per Minute for Average City.
1 000	1 000	28 000	5 000
2 000	1 500	40 000	6 000
4 000	2 000	60 000	7 000
6 000	2 500	80 000	8 000
10 000	3 000	100 000	9 000
13 000	3 500	125 000	10 000
17 000	4 000	150 000	11 000
22 000	4 500	200 000	12 000

Over 200 000 population, 12 000 gal. a minute, with 2 000 to 8 000 gal. additional for a second fire.

In residential districts: For villages or towns under 10 000 population, 500 to 1 000 gal. a minute, where the district is not congested; for cities over this population, or where the district is congested, 1 000 to 3 000 gal. a minute, with up to 6 000 gal. a minute in densely built sections of 3-story buildings.

In considering the reliability of source of supply the effect on adequacy must be considered for such items as frequency and duration of droughts, physical condition of intakes, danger from earthquakes, floods, forest fires, ice dams and other ice formations, silting up or shifting of channels, absence of watchmen where needed, etc.

The pumping capacity must be such that with the two largest pumps out of service the remainder in connection with such storage as may be available must be sufficient to maintain maximum consumption and fire flow at required pressure. For cities requiring less than 5 000 gal. fire flow, the relative infrequency of fires is assumed as offsetting in part the probability of a serious fire occurring at times when pumps are out of service, and allowance is made accordingly.

In cases where both low-lift and high-lift pumps are provided and reliability of supply is dependent on each, they must be considered separately and the sum of the points of deficiency applied.

Boiler capacity with a reserve of one quarter the entire capacity, and in any case at least one boiler must be sufficient to operate all machinery and the pumps required to maintain maximum consumption and fire flow with allowance made for storage. Nominally, there must be sufficient boiler capacity kept under at one half required steam pressure to deliver full requirements in connection with storage for a period of two hours. With sufficient stack or forced draft capacity, an overload of 50 per cent. over the maker's rating is used for fire tube boilers and 100 per cent. for water tube.

The following forms and combinations of plant equipment, if of modern design and well constructed and installed, are assumed as approximately equal, advantages of each, if any, being in the order of their naming:

a. Centrifugal or reciprocating pumps driven by steam engines.

b. Centrifugal or reciprocating pumps driven by electric motor.

c. Pumps operated by water power.

d. Centrifugal or reciprocating pumps operated by internal combustion engines approved for this service. Duplicate ignition parts to be on hand for each engine. Adequate provision to be made for starting engines cold at least six times in rapid succession.

All equipment must be of a design applicable to the service; service record in the plant under consideration and in similar plants shall be considered, and actual operating conditions observed. Pumps to be free from knock, with low slip, and capable of operating at full speed. Boilers to be well set, in good condition and with proper semi-annual inspection service; stacks shall be substantially installed. Electrical equipment for power to be in accordance with National Electrical Code, and not liable to injury by water spray. Water-power equipment must be accessible and properly safeguarded; operating force to be competent.

A minimum of five days' coal supply should be provided; where long hauls, condition of roads, climatic conditions or other causes make a longer interruption of delivery possible, a greater storage should be provided. Gas supply should be from two independent sources or from duplicate gas producer plant, with a storage of at least twenty-four hours' gas supply. Oil supply should be from underground storage of at least five days' capacity, with force feed to engine or boiler. Unreliability of gas or oil supply to boilers may be lessened by proper provisions for the use of coal. Water for power should equal at all times that necessary to meet maximum requirements and should have proper flood and ice control.

Steam piping (or gas or oil piping with internal combustion engines or to boilers) or electric transmission lines should be so arranged that a failure in any line, or the renewal of a valve, transformer or oil pump, would not prevent maintaining in connection with storage, maximum domestic consumption for two days, and fire flow for ten hours. Overhead electric lines introduce a degree of unreliability which may be in part offset by storage; consideration in connection with such lines shall be given to number and duration of wind, sleet and snow storms, character of poles and wires, character of country traversed, effect of forest fires and ease of and facilities for repairs; the use of the same transmission line from transformer or switchboard by other plants introduces a hazard of short circuit or prior use of power, and may be considered as the equivalent to the use of overhead lines in applying the Schedule.

Pumping stations and other portions of the plant should contain no combustible material in their construction; otherwise an automatic sprinkler equipment should be provided; outside hydrants and hose, inside standpipes and hose, and chemical extinguishers should be provided. Public fire station, if within three quarters of a mile, shall be considered as giving about one-half protection. If pumping station is not fireproof,

the several sections, particularly any with high potential generating equipment, shall be separated by parapeted fire walls and openings protected by standard fire doors and wire glass in metal frames. Station shall be protected against exposures. Electric wiring shall be in accordance with the National Electrical Code, and all internal hazards safeguarded.

Under the item of reliability of supply mains as effecting adequacy will be included any and all pipe lines or conduits on which supply to the distribution system is dependent; suction or gravity lines to pumping station, flow lines from reservoirs, force mains, etc., are included and a system may have one or all of these as part of it. Consideration must be as to greatest effect on maximum consumption and fire flow at required pressure that a break could have. If remaining pipes and storage cannot deliver even maximum consumption, allowance is made for only that amount available at required pressure. In applying, all mains which deliver from a source of supply or of storage to the high-value district must be considered. Aqueducts, of good design and of substantial construction, such as masonry or concreted steel, if properly installed, shall be considered sufficiently dependable as not to require duplication, and no application will be made as to the effect of a possible break.

Under the assumption of the most serious single break, when capacity of mains from the source of supply is less than maximum consumption, deficiency shall be considered as offset by storage when the difference between maximum consumption and the capacity of the mains is equaled by one fifth the storage after deducting fire flow for ten hours, except as restricted by the capacity of the mains from the storage. When capacity of the mains from the source of supply is more than maximum consumption, the excess capacity plus 2.4 times the storage shall be considered as offsetting deficiency if equal to the fire flow in million gallons a day. The effect of a break in suction or discharge headers, lack of by-passing or poorly gated by-pass or arrangements at any reservoir, filter, etc., poorly arranged cross-connections, etc., must be considered; also features which would tend to cause or prevent an interruption of service, such as length of line, and two or more lines from the same or different sources or from storage.

Deficiency for each individual possible break is considered, and charge made for the case giving the maximum total number of points, including the increase due to distance.

In considering the reliability of installation of supply mains it is assumed that they must be in good condition and reliable; cast iron, wrought iron, wood stave, and masonry conduit have been found satisfactory, in various places and under certain conditions; service records and general conditions must be considered. Mains should be laid so as not to endanger each other, and their failure at stream and railroad crossings and other points where physical conditions are unsatisfactory should be guarded against; they should be cross-connected and gated about

once a mile, and equipped with air valves at the high points and blow-offs at the low points.

The general arrangement of valves, specials, and connections at cross-overs, intersections, reservoirs, and discharge and suction headers must be considered with the view to quickness in shutting down breaks; the need of check valves on supply or force mains, and other arrangements to prevent emptying of reservoirs at time of a break in a main must be considered, as well as ease of repair in case of breakage. If there is more than one main, and conditions do not affect all, application is made in proportion to the carrying capacity affected and the degree of unreliability.

The arterial system includes the main arteries and secondary feeders which extend throughout the system. These feeders should be of sufficient size considering their length and the character of the sections served to deliver the fire flow necessary for the district. The basis of deficiency is applied by the results obtained in the fire-flow tests and general consideration of the arrangement.

Mains of the arterial system should not be laid across filled ground, and should have special construction at railroad crossings and near bridge abutments, and should be so gated that not more than one quarter of a mile within the distribution system will be affected by a break. All mains should have sufficient cover to prevent freezing, with a minimum cover of 2 ft. to prevent injury from traffic.

In considering the minor distributors and gridiron system, 6 in. is considered the minimum size satisfactory for hydrant supply in residential districts, to be closely gridironed with 6-in. cross-connecting mains at intervals not exceeding 600 ft., or where initial pressures are high a satisfactory gridiron may be obtained by a liberal per cent. of larger mains cross-connecting the 6-in. at greater intervals; in new construction, 8-in. should be used where dead ends and poor gridironing are likely to exist for some time, and 6-in. only where blocks are 600 ft. or less in length. In high-value districts, the minimum size to be 8-in., with cross-connecting mains at distances as given above; 12-in. and larger mains to be on the principal streets and for all long lines not cross-connected at frequent intervals.

The mains of the distribution system should be of satisfactory quality and properly tested for soundness and tightness of joints. The use of cast-iron pipe under pressure double that specified for the class is considered as introducing an unreliable feature, particularly where pressures are raised for fires; tests before back-filling the trench and service records of several years may, however, be assumed as offsetting this defect in part.

Electrolysis conditions should be studied, and methods of prevention applied.

The distribution system should be equipped with a sufficient number of gate valves, so located that no single case of accident, breakage, or repair to the pipe system exclusive of arteries will necessitate the shutting from

service a length of pipe greater than 500 ft. in high-value districts, or greater than 800 ft. in other sections, and will not result in shutting down an artery. All valves to be inspected yearly, and large valves more frequently, and be kept in good condition; the presence of some valves operating in opposite direction is to be considered the equivalent of unsatisfactory condition, ranging from fair to poor, depending on the number and importance.

In considering hydrant distribution it is readily apparent that proper distribution depends first upon whether the system is on a direct hydrant or engine stream basis, realizing of course that wider distribution could be permissible where engines were ordinarily used than where hydrant streams were utilized, also that the fire flow required for the district is a determining factor, as the same distribution cannot be expected in a residential district as would exist in a manufacturing or mercantile section. We, therefore, determine what our required fire flow should be and then use the following table.

ENGINE STREAMS.

Fire Flow Required. Gallons per Minute.	Average Area per Hydrant. Square Feet.
1 000	120 000
2 000	110 000
3 000	100 000
4 000	90 000
5 000	85 000
6 000	80 000
7 000	70 000
8 000	60 000
9 000	55 000
10 000	48 000
11 000	43 000
12 000	40 000

DIRECT HYDRANT STREAMS.

1 000	100 000
1 500	90 000
2 000	85 000
2 500	78 000
3 000	70 000
4 000	55 000
5 000 and over	40 000

Hydrants should be inspected in the spring and fall of each year; after use at fires during freezing weather and daily in high-value districts during protracted periods of severe cold.

The standard requirements for hydrants specifies that they should be able to deliver 600 g.p.m., with a loss of not more than $2\frac{1}{2}$ lb. in the hydrant and a total loss of not more than 5 lb. between the street main and hydrant outlet; they should have not less than two $2\frac{1}{2}$-in. outlets and

also a large suction outlet where engine service is necessary. They should also be of such a design that when the hydrant barrel is broken off the hydrant will remain closed. Street connection should be not less than 6-in. in diameter and should be gated. Flush hydrants requiring chucks to be screwed on are considered undesirable, especially in sections of the country subject to heavy snow storms, because of delay in getting into operation.

Buildings of fireproof construction, sprinklered brick buildings, fire breaks, fire barriers, and separate high-pressure fire systems designed to deliver capacity at 90 lb. hydrant pressure or more, form important mitigating features.

Credits.

The subjects considered under Credits are as follows:

Item.

21. Superior Construction and Protection.
22. Fire Engine Capacity where Water Supply at Direct Hydrant Streams is Adequate.
23. High-Pressure Fire System.

(*Note.* Items apply only to the high-value district considered.)

Buildings of fireproof construction and sprinklered buildings tend to offer a barrier against a spreading fire as well as offering the fire department a vantage point in preventing a fire from gaining conflagration proportions, and credits are allowed accordingly.

Where the full fire flow is available as direct streams either from a domestic water system or from a high-pressure system, the maintaining of engines in service, with adequate provisions for their response and operation, is considered an advantage as reducing the probability of a fire gaining headway in the interval of time necessary to control the flow from a broken main, and credit should be allowed accordingly.

A high-pressure system may have a gravity supply, direct pumpage supply, or a combination of the two. It may be a separate system for fire service only, or may be the extension of a high-service domestic supply into a low-service area, in which latter case only two thirds the actual fire flow obtainable should be assumed as available capacity. Fire-boat pipe lines should also be considered. To be standard, a high-pressure fire service must comply fully with the various items listed under Water Supply and be capable of delivering in the weakest part of the system the full fire flow required, including that necessary for a second fire, such supply to be available in an area equal to that served by the number of hydrants necessary to deliver this required fire flow when discharging 1 000 gal. a minute each. For standard fire service this quantity should be available at a residual pressure of 250 lb., residual pressures less than this down to 90 lb. as a minimum, permit classing a system as a high-pressure fire system, but of less worth in reducing the deficiencies in structural condi-

tions. Hydrants should be of ample dimensions, with four independently gated hose outlets and with 8-in. gated connections to the mains, to be so distributed that the entire area of the district is protected and the average area served per hydrant will not exceed 40 000 sq. ft.

Discussion.

A Member. I should like to ask Mr. Caldwell what he considers the pressure that would determine where a 4-in. line would be satisfactory in a gridiron connection.

Mr. Caldwell. We do not recognize 4-in. pipe as furnishing an adequate supply where fire streams are to be depended upon. In other words, there is a direct penalty in the schedule for the use of 4-in. pipe, but this charge is reduced where pressures are over a certain point. That is, we deduct a proportionate charge, realizing of course that the pressure will offset the 4-in. pipe to some extent.

A Member. About what pressure did you decide on?

Mr. Caldwell. That would vary with the character of the district. Of course, we consider in the average residential district where the system is on a direct hydrant stream basis that the full fire flow should be available at 60 lb., but in some districts we permit that as low as 50 lb. In high-value districts, we require it at 60 lb., unless a number of buildings are in excess of four stories in height, and then we require 75 lb.; on an engine basis the full flow is required at 20 lb.

Mr. Frank A. McInnes.* What is the status of the 4-in. hydrant?

Mr. Caldwell. I think I can answer Mr. McInnes's question. Of course in new installations you rarely find 4-in. hydrants, but you generally find some 4-in. mains in the distribution system, although, of course, 4-in. hydrants are not always attached to mains of that size. But where we have already penalized the distribution system for the existence of 4-in. mains we reduce the charge for 4-in. hydrants.

President Macksey. Where there are 4-in. hydrants, off of 4-in. mains, they are usually old installations, but there are a great many installations to-day where a hydrant with a 4-in. valve is connected with a 6-in. main; and I think that, regardless of the penalties which the Insurance Board may put upon them, that is going to continue, because the water-works people believe that in many cases it is the most practical thing for them to use, and the best investment.

Mr. George W. King.† If two of the pumping engines were out of commission what remains should be of a capacity of the required maximum amount at the fire streams?

Mr. Caldwell. Yes.

Mr. King. In other words, it is required to furnish enough pumping capacity in triplicate to supply the maximum demand.

* Division Engineer, City of Boston, Mass.

† Superintendent, Water Works, Taunton, Mass.

MR. CALDWELL. That would be in connection with available storage, which would always be included under the item of pumping equipment. We grade two ways on the pump capacity. We assume, first, that the largest unit in normal operation is out of commission, and figure the available capacity in connection with storage of the remaining units, and the full scale deficiency applied. Then we consider, with two units out, how much is remaining, but there we do not apply the full deficiency charge, feeling that that is more or less of a remote possibility, but still it is possible.

In this connection the New Bedford situation, I think, would be interesting for the Association to know; that is, the New Bedford system, of all of the systems in New England that we have applied the Schedule to so far, shows the least points of deficiency against it. As I recollect, it was sixty odd.

A MEMBER. I think it is down to approximately thirty now.

MR. CALDWELL. The fact that this is out of a possible 1 700 points, shows that the Schedule is practical, and that we are not requiring things which are an impossibility, because here is one city that has met those requirements, and without any action on our part, because we have not put the Schedule into effect in New Bedford yet.

MR. A. E. MARTIN.* Would you make a charge against the city that maintains a 4-in. parallel line in a street where there is already a main large enough to carry fire protection?

MR. CALDWELL. No, sir; we would not. We would consider the larger main; providing, of course, that that main was sufficient, or that the large main in connection with the 4-in. was sufficient to furnish the flow for that particular section.

MR. MARTIN. I meant to have added that there was no hydrant, or would be no hydrants, connected with the 4-in. pipe.

MR. CALDWELL. No. We only penalize the 4-in. pipe where supplying hydrants. There would be no penalty attached to the use of 4-in. pipe for domestic service only.

MR. MARTIN. In the case of this 4-in. parallel main being maintained for services only, and the other main not allowed to be tapped for services, is there any credit allowed?

MR. CALDWELL. That will show up in the fire-flow tests. If we had a situation like that we would give credit by conducting a test on the main that did not have the service connections.

MR. S. H. TAYLOR.† I should like to call attention to a case where a penalty was imposed for a hydrant on a dead end. In the outlying districts we laid pipes to supply one or two houses and put a hydrant on the end. Now, if a waste gate were placed there, and no hydrant, the penalty would be eliminated.

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* Superintendent, Water Works, Springfield, Mass.

† Assistant Superintendent, Water Works, New Bedford, Mass.

MR. CALDWELL. I think we all know where Mr. Taylor comes from, and as his system has only thirty-odd points deficiency I think you must agree that we are not very severe on him for his hydrants on dead ends.

MR. WILLIAM F. SULLIVAN.* Would you penalize a city that had 4-in. pipes, and had those 4-in. pipes reinforced with a gridiron so that it gave a fire flow?

MR. CALDWELL. I think you have assumed almost an impossible condition there. It would be almost impracticable to so reinforce a system of 4-in. pipes. But still, if such a system would furnish the required fire flow we would be obliged to give it credit.

MR. J. H. HOWLAND.† I should like by way of explanation to supplement Mr. Caldwell's answer to Mr. King's question. There might be an impression that making a charge for two pumps out of service was rather excessive. Perhaps a good many of you remember an experience that was had at Little Rock, Ark., about five or six years ago. They had three pumps in service. The largest pump, I think, broke the cylinder head, and in order to keep up with a very high rate of consumption the second largest pump was speeded up. That broke down, and then the last pump broke down, exhausted the reservoir on the hill; but they shut off that reservoir with about two feet of water in it, leaving the town without any water supply. So that while the charge, as Mr. Caldwell has explained, is a big one when there was but one pump out of service, I think we are justified in making a charge in case of two pumps being out of service. It is quite liable. It has happened not only in Little Rock but in other cities.

There is one matter that I have often wondered whether we were unduly disturbed about, and that is the introducing of a charge for unreliability where pressures in mains exceeded double or were equal to double their designed working pressure. Springfield, in abandoning the Ludlow system, where I think they had a pressure of about 85 lb. in the congested districts, brought in the Little River supply with 140 lb. in the business district, and I think that our engineer in Springfield will tell you that there are a number of places where he has got 43-lb. pipe withstanding that pressure to-day. Syracuse, N. Y., if I remember rightly, practically doubled her pressures when they brought in a new reservoir on higher pressure, bringing the pressures from somewhere in the neighborhood of 40 lb. up to approximately 90 lb.; and in Syracuse you will find a pretty liberal per cent. of 43-lb. pipe. I know this matter has been discussed at the National Board conferences, and we think we are justified in charging for pipe that is withstanding double its working pressure.

MR. GEORGE CASSELL.‡ If a building has a 6-in. connection going into it from a 12-in. main, with 100 lb. to the square inch, and the owner of that building should desire to have another 6-in. taken off that same

* Engineer and Superintendent, Pennichuck Water Company, Nashua, N. H.
† Engineer, National Board of Fire Underwriters.
‡ Water Commissioner, Chelsea, Mass.

main, into that same building, for a sprinkler service, would it be advisable to do so, in your opinion?

MR. CALDWELL. Of course that would depend somewhat on local conditions. The size of that pipe would be determined by the construction, the area, and the occupancy of the building in question. I am heartily in sympathy with this idea of the water-works people, against installing too many large-sized sprinkler connections; still, at the same time you do not want to go the other way. Now, we have a whole lot of cases where we do not think we should be limited to a 4-in. connection where the area or occupancy is considered, and the number of sprinklers supplied distinctly requires more than what the 4-in. pipe would deliver. So I am afraid I cannot answer that question definitely, but I can appreciate the fact that in some cases it would be undesirable, from the water-works point of view, to permit two 6-in. parallel connections right off a 12-in. main.

MR. CASSELL. It seems to me from my experience that if a 6-in. pipe, with 100-lb. pressure, will take care of 200 sprinklers, and they say there shouldn't be any more, there must be some pressure left behind.

MR. CALDWELL. Yes, there is.

MR. CASSELL. So that it would naturally supply an adequate amount of water for 200 sprinklers. Now, if that is the fact, why is there any necessity of having any more, unless to provide against accident to that particular line?

MR. CALDWELL. We never bring in duplicate lines for that purpose; but, if the requirements call for more than 200 sprinklers, then either an additional 6 in. or 8 in. must be installed; that does not mean necessarily from the street. It might be brought in from the yard system, if the plant was a large one and they had a private pipe system of their own.

MR. CASSELL. Don't you think it is much better under those conditions to supply two 4's instead of one 6, so that in case one line breaks the other line will be in operation?

MR. CALDWELL. Under the item of reliability you are absolutely right; on the item of adequacy you are not. There is not the carrying capacity in two 4's that there is in one 6-in.

MR. CASSELL. Which, in your opinion, would be preferable, a 6-in. or two 4's?

MR. CALDWELL. My answer to that would be determined entirely by the nature of the building and the occupancy that I was attempting to protect. If I had a building which was readily ignitable, or I had an occupancy that was liable to produce a flash fire, give me the 6-in. connection; give me all the water just as quickly as you can get it. But if I had the ordinary occupancy and slow-burning construction, I am not so sure but what I would lean to the two 4-in. connections.

MR. CASSELL. I might agree with you. Now, if a 6-in. sprinkler system is connected with a high-service main that furnishes water to the higher elevations in a city, and the water pressure at the highest point is

40 lb. and at the lowest is 100 lb., and a break should occur in the 6-in. sprinkler service and the discharge of water from it reduces the pressure so that no water would be available for the properties on the higher elevations, are we not jeopardizing the lives and the property of the people there?

MR. CALDWELL. That is true.

MR. CASSELL. Then, Mr. Caldwell, it seems to me that it is very unwise to take such a chance as that, because the only difference I can distinguish between the two is this, — that one reduces the premiums and the other jeopardizes the lives and property of the other people.

MR. CALDWELL. Do you think experience has shown that?

MR. CASSELL. No; but, as somebody said, a minute ago, the inevitable always happens. It happened in my city in 1908.

While I and every water-works man who belongs to the Association wants to coöperate and do everything that is possible to create a high standard of efficiency for fire purposes, and to coöperate with the insurance companies, I think and feel that the insurance companies are crowding us a little bit when they are trying to force us to give these things that are really beyond the possibility of giving, without jeopardizing the lives and property of people in other sections of the city.

MR. CALDWELL. I think you are right. There is something to be said for and against both sides there. And I think in a great many cases undoubtedly the men who have laid out sprinkler equipments for different insurance organizations have not used good judgment as to calling for certain-sized connections. In fact, there have been numerous cases come to my knowledge where men have asked for connections from street mains where the street mains were not capable of supplying the capacity of pipe that they were asking to be installed.

MR. CASSELL. I wish to give the property owner everything I possibly can, and, if possible,to satisfy the insurance people. I think that so far as my city is concerned we have done so. The one mistake we made in that line was to give a 6-in. supply, because our capacities are not very large, as you know, although we are very well fixed.

PRESIDENT MACKSEY. When the underwriters lay out a sprinkler outfit for a plant, and try to provide a supply for it, do they call for a supply that will cover all sprinkler heads in the plant open at one time?

MR. CALDWELL. No, they do not, Mr. President. The size of the supply is dependent upon the number of sprinklers in a given floor area. In other words, we might have a building 200 ft. long, 50 ft. wide, and four stories high. Now, we couldn't call for a supply which would take care of the total area of that building for all four floors, but we assume only one floor at a time. In other words, we would lay out the necessary sprinklers for an area 200 by 50 ft., for one floor; — the size of supply main in that building would be designed to take care of that one floor alone.

PRESIDENT MACKSEY. In other words, the probability of two or three fires coming at one time is not as great as the probability of two or three pumps breaking down at one time, and therefore is not provided for.

MR. SULLIVAN. Regarding the financial phase of this problem. How are the water works, without funds, going to fix up their systems, maintain operation, and keep it up so that they won't be penalized, and get this 1 700 points? I cannot see where we are going to get all these improvements done without money; and as competent managers of water works you have got to conserve the money you have. You cannot replace all the 4-in., 6-in., and 8-in. pipe with pipe of diameters large enough to ensure in every part of the city or town a sufficient fire flow. There is no city or town that wants the weak spots. I do not recall that Mr. Caldwell is interested in the financial end of the question. But it is a question to-day. I do not know of any water departments, or companies, that are paying 100 per cent. at any time; but I do know of some insurance companies that have — though I did not bring that up as a matter of discussion. [Laughter.]

MR. PATRICK GEAR.* I never knew in this country of any system that was up to the standard that is required by the insurance companies. We had them in Holyoke, grading us in 1915. They gave us a penalty of 156, but we got back at them, and got off 22 or 23 points.

Now, they penalized us for 4-in. hydrants, but I do not agree with them, for there is a place in the small city or town for the 4-in. hydrant, even with one nozzle.

MR. H. C. CROWELL.† Mr. Caldwell, do not some cities restrict their fire service connections to 4-in.?

MR. CALDWELL. Yes, I think they do, Mr. Crowell. We do not have jurisdiction in Boston, but I think I am correct in saying that they will permit only 4-in. sprinkler services. They will permit more than one, if the area of the building demands more than what the 4-in. will supply. Didn't you follow that practice out in Woburn, Mr. Macksey?

PRESIDENT MACKSEY. Yes, we made a 4-in. rule in Woburn. In the town, where small pipes had to supply a number of people, we believe, as does Mr. Cassell, that we ought to look after the interest of the whole and pay very little attention to the individual problem.

MR. CROWELL. What would be the result in Haverhill if they restricted their fire services to 4-in.? A great many of the mains are small. We have both high and low pressure there.

MR. CALDWELL. You do not mean by that to replace any existing 6-in.?

MR. CROWELL. Well, I referred to new ones; but of course personally I believe that the fire services are too large, considering the size of the mains.

MR. CALDWELL. That would be a point that would not come under my jurisdiction; but my thought on that matter would be that in those cases where the 4-in. supply would meet the area occupancy and con-

* Superintendent of Water Works, Holyoke, Mass.
† Superintendent of Water Works, Haverhill, Mass.

struction conditions I don't see why they should make any difference in rate. It is a problem that has been discussed for years, and there is something to be said on both sides of it; but it does seem to me that the interests of the water companies and the insurance interests certainly are mutual. We are after the best protection possible to safeguard the owner of the property and the integrity of the water system. I realize that in numerous cases undoubtedly there have been what you would call layouts made for individual sprinkler equipments, which would be open to some criticisms, but I don't think you should blame the system so much as you should blame the individual who laid out that system. But I do believe there is such a thing as getting together on this thing and accomplishing or at least working out a plan which would be satisfactory both to the water interests and the insurance interests.

MR. CROWELL. In Haverhill quite a lot of the mains are too small. The National Board of Insurance Underwriters have been in Haverhill several times, and I think that they want to do all that they can to help out every city.

MR. MCINNES. Why shouldn't the Standard Schedule penalize unduly large connections from the mains of a distribution system for fire or other purposes? Such connections exist and constitute serious danger spots which should logically appear as points of deficiency in the Schedule.

MR. HOWLAND. Is there any member of this Association present who knows of one instance in the country where 6-in. or larger connections of sprinkler systems have seriously depleted the water supply?

A MEMBER. Jacksonville.

MR. RICHARD D. CHASE.* Some years ago I had occasion to look this thing up and collected quite a number of instances where most serious difficulty had occurred with large connections collapsing, reducing the pressure. In Rochester, N. Y., there was an 8-in. connection to a large brick building, the use of which collapsed it. The chief of the fire department came to the superintendent or engineer of the water board and told him that they were not getting any water; the superintendent, pointing to a big pile of brick in the street, said, "Until you get this pile of brick off I cannot close that gate." It seems to me the Salem fire was pretty closely connected with a couple of large sprinkler connections that were destroyed. I firmly believe these are a serious menace to any distribution system.

MR. SULLIVAN. I believe in the JOURNAL of the Water Works Association the gentlemen will find an unusually well-written paper on this subject by Messrs. McInnes and Goldsmith, in regard to the Salem fire.

* New Bedford, Mass.

GENEVA.

Introduction to Monsieur Bétant's Paper.

PROF. GEORGE C. WHIPPLE.*

[*Read December 8, 1920.*]

In view of the fact that you are to listen to a paper describing the water supply of Geneva, by Monsieur A. Bétant, engineer of the water service of that city, and also that Geneva has been selected as the headquarters of the League of Nations, it may not be inappropriate for me to tell you in a few words what kind of a place Geneva is. I resided there for eight months, — that is, from February to September, 1920.

Geneva is situated in the extreme southerly part of Switzerland, and is almost completely surrounded by France. Consequently it is essentially a French-speaking city. At the census of 1910, 70 per cent. of the people spoke French, 12 per cent. German, and 9 per cent. Italian. In 1910 the population was 123 153. In 1919 it was estimated to be 141 000, being the third largest city in Switzerland. Zürich and Bâle (Basel) are larger than it, but Bern, the capital, is slightly smaller.

Geneva is situated at the foot of Lake Geneva (Lac Leman), which is an expansion of the River Rhone, about 50 miles long and 10 miles wide. The Rhone River rises in the north, near the St. Gothard Pass, and is a muddy glacial stream, especially in the summer when the glaciers are melting. The turbidity settles out in the lake to a considerable extent. At Lausanne, which is half way down the lake, the water is not suitable for public supply, and this city has extended its aqueduct far to the north in order to obtain water from the mountains. The sewage of Lausanne empties into the lake. At Geneva the water is usually beautifully clear and of a bright blue color, but at times it shows the presence of colloidal matter. During periods of high wind, and especially when there is a "*bise*" blowing down the lake, the water becomes greenish in the middle and brownish near the shores. Such analyses as have been made indicate that the water is probably safe for drinking; but in view of the pollution which the lake receives at various places it cannot be asserted that the final word has been said on this point. Just above the outlet of the lake there are two jetties which extend into the water, forming a sort of basin which in many respects reminds one of the Charles River Basin in Boston, especially at night when the shores are fringed with rows of electric lights. The current becomes quite swift as the water enters the Rhone River. Just below the

* Professor of Sanitary Engineering, Harvard Engineering School.

outlet is the power plant described by M. Bétant in his paper. A few miles farther down stream there is a hydro-electric plant, also mentioned in his paper. The sewage of the city is discharged untreated into the Rhone, but there is a very great dilution.

Historically, Geneva is one of the most interesting cities of the world. It was a thriving place when Cæsar made his conquest of Gaul. Some of the old Roman walls are still standing, and the site of the bridge which connected the land of the Helvetians with the land of the Allobroges is still occupied by an important bridge crossing the Rhone. Geneva as a city has led a sort of independent life, and, according to the fortunes of war, has been under various authorities, the stories of the early wars being full of interest and excitement. Geneva was the home of John Calvin, and the Calvinistic influence on the city has been very great. It was one of the early seats of Protestantism, but at the present time the population is about equally divided between Catholics and Protestants. The city centers around the St. Pierre Cathedral, which dates from the tenth century. Calvin preached in this church, and near it stands the high school which he built in the fifteenth century and to which all of the Genevan boys go. There are some notable statues of Calvin and other leaders of the Reformation, including Oliver Cromwell and Roger Williams, in the park which surrounds the university. Geneva has always been a city of refuge for persecuted peoples, and this to some extent accounts for its large French population. More than almost any city with which I am acquainted Geneva treasures its educational and spiritual traditions.

The City Hall in Geneva is a very fine example of old architecture. It contains several famous rooms. The Salle d'Alabama is the room in which the Red Cross movement first took shape in 1863, and where in 1872 the Alabama Claims between the United States and Great Britain were adjusted. The Council Chamber was the seat of the first International Red Cross Convention, in 1864. Both of these rooms were recently used in connection with the first conference of the League of Red Cross Societies in March, 1920.

Geneva is fast getting to be an international city. Many conventions in recent years have met there. It has for many years been the headquarters of the International Red Cross Committee. It is now the headquarters of the League of Red Cross Societies, and quite recently the League of Nations has purchased one of the largest hotels on the shore of the lake as the headquarters of its secretariat. It is expected that, little by little, other international bodies will locate there until this city becomes what the Genevans are already beginning to call it, "the capital of the world."

Geneva is in many ways fitted to be such a capital. Traditionally it has an independence not found in other European cities. It is a neutral city in a neutral country, removed from the ordinary lines of commerce and manufacturing. It is a comfortable place to live in, has fine buildings, good hotels, clean streets, and in general is a well-organized municipality.

It is surrounded by inspiring mountains, the Juras on one side and the Alps on the other. It is an intellectual center, the seat of a great university and of many schools. Geneva has never taken pride in its growth. Naturally, some of the commercial interests have endeavored to boom the place for business reasons, but, so far as the old residents of Geneva are concerned, they do not take pride in the increase of population. In fact, they are somewhat inclined to resent the intrusion of so many people from outside. They have not liked to see the numbers of automobiles increase, and they have made strict laws in regard to their " circulation," especially on Sunday. They enjoy the peace and quiet of their beautiful little city. Nevertheless they are proud of seeing it assume such an important place in the world.

Monsieur A. Bétant, the engineer of the water service of Geneva, is a typical water-works man, and would fit in very well with the members of this Association. I am sure that we all welcome M. Bétant as a contributor to the JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION. He takes a keen interest in the quality of the Geneva water, and has for a long time kept up regular quantitative tests of the plankton, — that is, the microscopic organisms. On visiting his office, one day, I was surprised to find on his shelves a copy of the latest edition of my own book on " The Microscopy of Drinking Water." This leads me to make mention of the admirable pioneer limnological work carried on by Dr. Forel at Lausanne more than thirty years ago. A physician by profession, he studied Lake Geneva in all its aspects for many years, and the result was a three-volume book in French, known as " Le Leman," the first great work on limnology. This was one of the first books on this subject which I ever studied and one which I used a great deal in connection with the biological work at the Chestnut Hill Reservoir during the years 1889 to 1897. Last summer I took peculiar pleasure in presenting to the library of the University of Lausanne a copy of my book, in which I had inscribed a few words of appreciation of Dr. Forel's work, and the influence which it has had on the development of limnology in America.

THE WATER SUPPLY OF GENEVA, SWITZERLAND.*

BY MONSIEUR A. BÉTANT.†

[*Read by Prof. George C. Whipple, December 8, 1920.*]

The city of Geneva, as well as the greater part of the *canton* of the same name, comprising in all a population of about 148 000, is supplied with unfiltered water from Lake Geneva. The water is pumped by hydraulic turbines which have a capacity of 3 000 h.p., the necessary driving force being supplied by the Rhone River at Coulouvrenière, near the outlet of Lake Geneva.

The distributing system extends over a radius of 15 km. (9.3 miles) from the pumping station. The quantity of water pumped in 1919 was 46 654 757 cu. m. (12 310 million gallons), of which 24 146 233 cu. m. (6 370 million gallons) was used for household purposes and 22 508 524 cu. m. (5 940 million gallons) for power purposes, the average domestic consumption being 447 liters (118 gal.) per capita daily. The average daily consumption was about 34 million gallons, of which 17.5 was for household purposes.

Pumping Machinery.

The pumping machinery consists of 18 Jonval turbines with vertical axis designed for falls of 1.8 to 4 m. (5.9 to 13.1 ft.). Each turbine directly engages a double Girard pump equipped with piston plungers. The two parts of this pump are placed at right angles to one another and form independent groups of 250 h.p. capacity.

The heads on the pumps correspond to those of the distributing systems. Three low-pressure pumps raise the water about 60 m. (196 ft.) and serve the lower parts of the city; five high-pressure pumps raise the water for the domestic supply of the *canton* 140 m. (457 ft.); and ten high-pressure pumps raise the water for power purposes throughout the city 135 m. (441 ft.).

Three centrifugal pumps operated by electric motors, one of 1 000 and the others of 500 h.p. capacity, are kept in reserve. Electric current is supplied to the motors by the power plant at Chèvres, lower down on the Rhone River. The reserve units are employed when the height of water in the river is not sufficient to give the turbines their normal head of water, a circumstance that necessitates the use of a different source of power.

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* Translated by George C. Whipple and Gordon M. Fair.

† Engineer and Director of Water Supply Service, City of Geneva.

Water for Domestic Supply.

The water used for household purposes is taken from the lake and is not filtered. After flowing across Lake Geneva, which serves as a very large natural sedimentation basin, the lake water contains no pathogenic bacteria and can be obtained pure from an intake situated at a sufficient depth and at a distance from the shores great enough to avoid accidental contamination from local sources.

The Geneva intake opening is at a depth of about 15 m. (49 ft.) and at a distance of 2.5 km. (1.55 miles) from the harbor jetties and 1.3 km. (0.81 miles) from the lake shore. The water runs to the pumping station at Coulouvrenière through a pipe 1.2 m. (48 in.) in diameter and 3 660 m. (12 000 ft.) long. The conduit is laid on the bottom of the lake and Rhone River. (See Fig 1.)

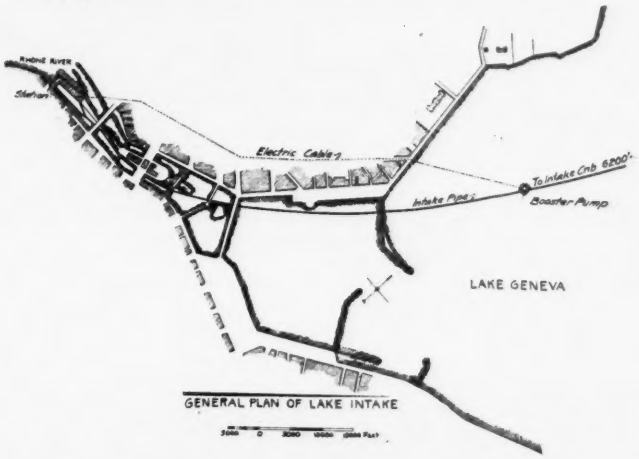

Fig. 1. Map showing the Location of Intake Pipe, Pumping Station and Booster Pump.
(Pumping Station at "Station," upper left-hand corner.)

Up to a few years ago the water flowed by gravity to the pumping station, because of the difference in level between the lake surface and the pump suction. The conduit then had a capacity of 600 to 800 liters per second (13.7 to 18.3 million gallons a day). In 1913, however, it became necessary in consequence of the steady increase in water consumption to enlarge the capacity of the conduit to 1 100 liters per second (25.2 million gallons per day). This was accomplished by installing an electrically-operated centrifugal pump in the line of the conduit. The pump site was located in the lake at a point 600 m. (1 970 ft.) from the jetty, in order to place under pressure the section of the conduit that passed under the harbor of the city. If, thereafter, one of the pipe joints should leak, the flow

would be outward and the water in the conduit would be protected against pollution.

For the purpose of connecting the pump to the intake, a sheet-iron caisson 7 m. (23 ft.) in diameter at the base was floated to the pump site and sunk by being filled with concrete. The caisson, resting in 4 m. (13.1 ft.) of water on the level bottom of the lake, was then secured by 16 anchor piles placed around its circumference, and the pump and motor were

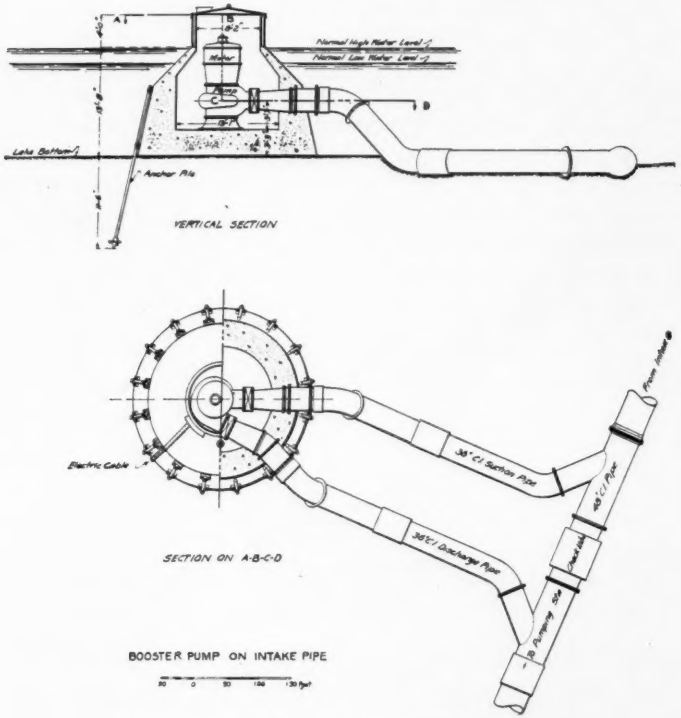

FIG. 2. SKETCH OF BOOSTER PUMP ON INTAKE PIPE.

mounted in the central cavity that had been provided in the caisson when it was filled with concrete. The vertical pump shaft is direct-connected to the motor which is mounted in the same frame. The pump is designed for a lift of 3 m. (9.8 ft.) and has a capacity of 66 cu. m. per minute (25.2 million gallons per day). It operates at a rate of 200 revolutions per minute and is driven by a 65 h.p. motor running on 3-phase alternating current. The electricity is provided by a special generator, operated by a high-pressure turbine at the Coulouvrenière station. An independent cable connects the two machines in short circuit, so that the whole installation can be operated from the pumping station.

After sinking the caisson, a 10 m. (32.8 ft.) section of the conduit was replaced by two special castings with side outlets, a check valve being inserted between them to permit the pressure to adjust itself automatically when the pump was started. The two side outlets were connected to the suction and the discharge of the pump by pipe-castings passing through the walls of the caisson.

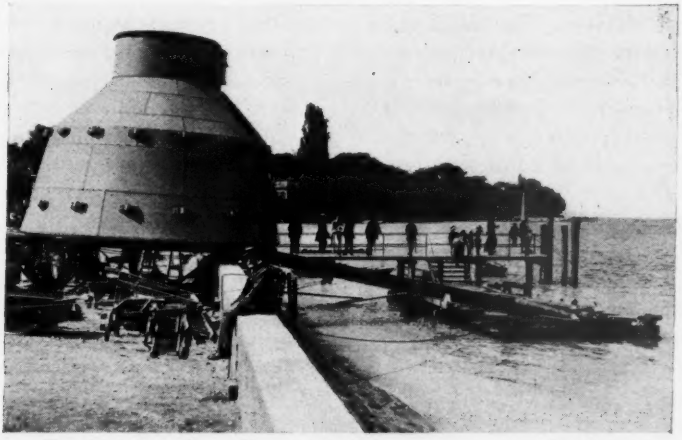

FIG. 3. SHEET-IRON CAISSON ON SHORE, READY TO BE LAUNCHED.

FIG. 4. CAISSON IN PLACE, SHOWING SUPPORTING PILES.

The installation was placed in service in June, 1914, and has since been in regular operation. As previously stated, it is controlled from Coulouvrenière, an arrangement which makes it unnecessary to visit the caisson oftener than once a month, when pump and motor are oiled.

Distributing Systems.

There are three distributing systems, the total length of pipes amounting to 471 km. (293 miles). Each system has an independent reservoir. That of the low-pressure system, providing the domestic supply for the lower part of the city, is situated at Bois de la Bâtie and has a capacity of 4 800 cu. m. (1.2 million gallons). The high-pressure reservoir supplying drinking water to the *canton* is at Bernex and holds 3 000 cu. m. (0.8 million gallons). The distributing system that provides hydraulic power for motors, elevators, vacuum cleaners, and other machinery, has its reservoir at Bessinge. As a constant pressure is necessary for this power service, the pressure at the lower end of the conduit leading to the reservoir is regulated by a centrifugal pump run by a 100 h.p. motor. The pump is placed in service during the day and increases the pressure by an amount equal to twice the loss of head in the conduit; this establishes equality between the day service (water level in the reservoir falling) and the night service (water level in the reservoir rising).

Certain distant parts of the *canton* too high in elevation to be reached by the general distributing system are supplied by small booster pumps, operated by electric motors of 5 or 6 h.p. rating, that take water from the general distributing system and pump it into secondary systems with reservoirs at some commanding place.

There are three of these secondary services, each with a booster station and a reservoir of 200 cu. m. (53 000 gal.) capacity. Two of these reservoirs, at Landecy and at Jussy, are water towers; the third is a standpipe on a hill at Choully.

The distributing system, therefore, has in all seven reservoirs:

Principal Reservoirs.

La Bâtie.....	4 800 cu. m.	(1 200 000 gal.)	Domestic service.
Bernex	3 000 cu. m.	(800 000 gal.)	Domestic service.
Bessinge.....	12 500 cu. m.	(3 300 000 gal.)	Power service.

Auxiliary Reservoirs.

For Domestic Supply of the *Canton*.

Chancy.....	200 cu. m.	(53 000 gal.)	
Choully.....	200 cu. m.	(53 000 gal.)	with booster pump at Satigny.
Landecy	200 cu. m.	(53 000 gal.)	with booster pump at Perly.
Jussy.....	200 cu. m.	(53 000 gal.)	with booster pump at Eaux-Vives.

Rates and Regulations.

The water rates of the city of Geneva are based upon the measurement of water by meter and pressure-gage. Meter rates are applied at present to nearly all connections; in some cases they are obligatory. The pressure-gage system was used at a time when the pumps were less powerful and the reservoirs of insufficient capacity. It was then a matter of importance to

operate the distributing system uniformly without sudden changes in pressure.

The gage-cock was placed under the sidewalk of the property served, and permitted the continual passage of a certain measured quantity of water. The consumer accumulated the water in a reservoir and used it according to his needs. The unit-measure of discharge was the "liter per minute." The consumer paid a price per year varying with the number of

FIG. 5. MOTOR READY TO BE LOWERED INTO THE CAISSON.

"liters per minute" received. This price was 48 francs for the low-pressure system in the city and 60 francs for the high-pressure system outside the city, corresponding to $36.30 and $45.40 per year for each "gallon per minute," if the Swiss *franc* is given a normal equivalent of 20 cents.

After the pumping equipment had been increased and new reservoirs had been constructed, it became possible to sell water everywhere by meter measurement. This was done especially in the *communes* (sections of the

canton) most distant from the pumps. The meter measurement system is now the only one used for new connections. It has the advantage of enabling the consumer to draw at any time the largest quantity of water required, an arrangement which does away with the use of tanks which caused stagnation and uncleanliness.

It is usually admitted that meter rates for the minimum yearly consumption should yield amounts sufficiently large to pay for the connection

FIG. 6. BOOSTER STATION COMPLETED.

and the general service expense. The minimum rate of consumption may be 300, 400, 800, 1 200, or 2 000 cu. m. per year for domestic services (79 000, 105 000, 211 000, 317 000, or 528 000 gal. per year). For small properties not exceeding 10 000 *francs* ($2 000) in value, however, the schedule fixes a minimum rate as low as 150 cu. m. (39 000 gal.) per year. The minimum charge is payable at the beginning of the year. The actual consumption is determined at the end of this time, and the consumer is charged for whatever the quantity in excess may be.

Contrary to the usual practice of cities in which the distribution of water has been made a business proposition, the minimum annual charge at Geneva is not fixed by the city. The consumer instead is given the privilege of choosing his minimum rate from the above-mentioned series. The prices per cubic meter follow a sliding scale, varying from 18 to 11 *centimes* per cu. m. (13.6 to 8.3 cents per 1 000 gal.), according to the limit of the minimum quantity. The consumer therefore finds it to his advantage to pay at the beginning of the year the price of the minimum rate most nearly approaching his actual consumption. For example, a consumer who uses 1 275 cu. m. during the year saves 27 *francs* ($5.40) by paying a minimum charge for 1 200 cu. m. at 13 *centimes* (8.25 *francs*), a total of 164.25 *francs*, instead of paying a minimum of 300 cu. m. at 15 *centimes* (45 *francs*) and an excess charge for 975 cu. m. at 15 *centimes* (146.25 *francs*), a total of 191.25 *francs*. The administration hereby secures the advantage of obtaining larger receipts at the beginning of the year, and the consumer profits by the lower rate. Meters are furnished without charge to domestic consumers.

In the water-power service which runs motors, elevators, vacuum cleaners, and other machinery, the charge for motors is made either by lump sum or by meter measurement. In the first instance, the price is fixed according to the number of brake horse-power furnished, and varies with the pressure from 400 to 140 *francs* ($20 to $7). In the second instance, the water is measured and the price varies from 7 to 3 *centimes* per cu. m. (5.3 to 2.3 cents per 1 000 gal.), with a minimum charge depending upon the pressure supplied. For elevators and vacuum cleaners, the water is also sold by meter, the minimum annual charge for this type of machinery being 100 *francs* ($20).

Tables showing the chemical and bacteriological analyses of Geneva water are appended. These were kindly furnished by Professor Christiani of the University of Geneva and chief of the Department of Hygiene of the canton of Geneva.

TABLE 1.

AVERAGE CHEMICAL ANALYSIS OF THE GENEVA WATER SUPPLY.

	Parts per Million.
Total residue (100° C.)	170–185
Mineral residue (180° C.)	160
Carbonates	90
Alkalinity	9
Total hardness	16
Temporary hardness	9
Permanent hardness	7
Oxygen consumed	2.2
Ammonia	Absent
Nitrites	Absent
Nitrates	Absent
Chlorides	2

TABLE 2.

SUMMARY OF BACTERIOLOGICAL ANALYSES OF THE GENEVA WATER SUPPLY. 1911—1919.

	Bacteria per C.C.			
	Minimum.	Average.	Maximum.	B. Coli in 10 C.C.
1911	15	106	221	0
1912	43	155	1 242	0
1913	21	89	153	0
1914	26	110	285	0
1915	11	95	440	0
1916	20	76	140	0
1917	10	82	302	0
1918	20	55	153	0
1919	29	180	568	0

DISCUSSION.

MR. SAMUEL E. KILLAM.* Can you give us the yield per square mile of the watershed of that lake?

PROFESSOR WHIPPLE. No, I cannot. The lake is about 50 miles long and 10 miles wide. The watershed is not very wide near Geneva, but it has the range of the whole Rhone River, which is a very large area.

MR. KILLAM. Also the width of the dam at the end of the lake — do you know that?

PROFESSOR WHIPPLE. Six hundred or eight hundred feet, perhaps.

* Superintendent, Metropolitan Water Works.

AIR IN GRAVITY MAINS.

J. W. LEDOUX.*

[*November 10, 1920.*]

Nearly every water-works superintendent has experienced trouble in connection with some phase of air in pipes. A leaky suction pipe often reduces the plant efficiency materially, and sometimes results in serious damage to the pumping machinery.

Where the discharge pipe is perfectly tight, if a small quantity of air be pumped with the water it is likely to accumulate on the summits and appreciably reduce the capacity of the pumping main, or, what is the same thing, increase the frictional head due to the reduced cross-section of the pipe at the summits. The remedy is to prevent the ingress of air at the pumping plant; but even at best more or less air is entrained with the water, and under reduced pressure at the summits this air may at times accumulate, and then the only remedy is to provide on these summits automatic air valves. However, this difficulty is not common, for several reasons. Unless it enters the pumping main in large quantities it is generally carried along with the water, and if an air obstruction develops the automatically increased pumping pressure tends to drive it over the summits by attrition. Also, air will escape through apertures too small to show water leaks, and there are usually enough of these to prevent noticeable trouble from pumping discharge mains. This property of air is often the cause of leaks, for in discharging at a high velocity it increases the size of the aperture by washing out fine particles of material that would remain in place if the pipe were full of water.

While the cushioning effect of air in mains often prevents serious water hammer, on the other hand its sudden escape at a high velocity, as sometimes happens, will produce serious water hammer.

The accumulation of air in summits of gravity mains has frequently resulted in the complete interruption of the supply on large portions of the system; and sometimes this phenomenon is troublesome and difficult of correction.

In one case in the experience of the writer a 14-in. main extended from a distributing reservoir, at elevation 628, across a valley the elevation of which was 150, to the opposite hill at elevation 550, where there was a considerable amount of population and very variable topography. Branches from this main extended at right angles in both directions to lower elevations. It was found that no water could be furnished on one of these branches, as was evidenced by the complaints of the consumers. The spigots were opened in houses, and the water would not flow even at

* Consulting Engineer, Philadelphia, Pa.

the ground floor. After many hours' investigation, a pocket of air under pressure was discovered at one of the summits, and as soon as this was released the supply was immediately resumed.

Another case consisted of a 16-in. gravity main from an impounding reservoir eight miles to two standpipes supplying the railroad service. It was found, one afternoon, that no water would flow into the standpipes, and it was immediately assumed that somebody had closed a valve or that the reservoir was empty, because there had not been experienced any trouble since the line was installed several months previously. An inspection was made; air valves were opened all along the mountain at the various summits; no water flowed and no air came out of the main. It was finally learned that, on the day before, a valve had been closed near the reservoir to make some slight repair on the line; on inquiry it was found that this valve had been reopened, and this was verified. It had been the intention to locate automatic air valves at all the summits. One of these summits was close to the impounding reservoir. Finally, this air valve was examined and to the surprise of every one it was found disconnected and lying in the valve pit. On opening the air valve connection the air escaped and the water began to flow freely. This particular summit was so close to the reservoir and so small as compared with the others on the line that no one suspected that trouble existed at that point.

The following diagram, Fig. 1, illustrates the principle.

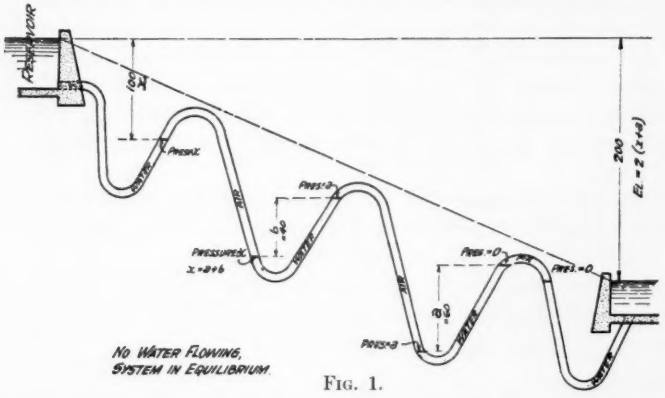

FIG. 1.

In this case the impounding reservoir is shown 200 ft. above the distributing reservoir, and under these conditions no water can flow through the line until the air is relieved at the summits.

Figure 2 illustrates about the conditions that occurred in the gravity supply to the railroad tanks.

The above examples show conditions of static equilibrium and a balance which is frequently very delicate. This condition is not likely to take place with pumping mains, where the pressures fluctuate, but is character-

istic of fixed levels of water as occur in gravity mains. At least, that has been the experience of the writer.

One of the most important conditions where serious damage can be caused on a pipe line is in the case of a large wood or steel pipe laid over summits and valleys. If, due to water hammer or defect in the pipe, an actual split or break of the pipe takes place in the valley, permitting a large quantity of water to discharge faster than the water can pass over the summit to keep the pipe full, a partial vacuum occurs, and unless the pipe

FIG. 2.

is designed to resist it, collapse will take place. The only remedy for this danger is to maintain a sufficient number of poppet valves designed to take large quantities of air into the line automatically; some very serious damage has taken place, due to the absence or insufficient size of these automatic poppet valves.

A vacuum is sometimes caused in a pipe line for another reason: Let us suppose a large wood or steel pipe line extends from a distributing reservoir down the hillside to a flat 200 ft. below, and that the pipe line is full of water but not flowing. Now, if between the base of the hill and the distributing reservoir a valve be shut, the pressure at the downstream side of the valve will at once drop to almost a complete vacuum, because this part of the pipe line is relieved of the atmospheric pressure acting on the distributing reservoir. Under these conditions collapse of the pipe is likely to take place.

In connection with this subject, it may be well to call attention to the best method of filling a gravity piping system that has been for some cause emptied. The writer has heard many experienced water-works men advocate filling the pipe line by sections. This is a very bad practice. The best method is to open air valves at all the summits, and open the blow-off valves in all the hollows and a sufficient number of hydrants in the town. Then the valve at the impounding reservoir is opened a sufficient amount to fill the line in a predetermined time. As soon as the water appears at the first blow-off and flows full, this is shut, and as soon as it flows full at the second blow-off, that is also shut, and so on, until the water appears at the city hydrants, shutting the low ones first and following them up until the high ones are shut; finally, the air valves on the line are closed and the line is in service, and no danger of water hammer has been experienced, and the line is filled in a shorter time than can be done by any other method.

WASTE RESTRICTION IN BOSTON.

FRANK A. MC INNES.*

[*Read November 10, 1920.*]

The following is the story of a small skirmish in the everlasting war against waste which is the heritage of every good water-works man:

In 1919 the daily average consumption of Boston was 89 652 400 gals. and the daily per capita 111 gals. A subdivision of the total consumption, made possible by the manner in which the supply is measured, pointed to the Charlestown District as probably a great offender from the point of view of waste. This district has a population of approximately 34 500, a pipe mileage of 31.9 and an unusually large industrial consumption. It is very thickly settled and entirely metered.

A contract for a waste survey was made with the Pitometer Co. of New York, the work to include a test of the Venturi meters measuring the flow into the district; a division of the district into sections and a measurement of the flow into each section; a detailed investigation in all sections where excessive waste is indicated and the location of actual leaks; a check on all large consumers for the purpose of determining unauthorized use of water, and a test of all fire pipes and meters larger than 3-in. The survey was begun May 10, 1920, and completed July 30, 1920.

The result of the work was a saving of 955 000 gals. in a week-day average daily consumption of 6 582 540 gals.,— a little more than 14 per cent. The leaks located and stopped were as follows:

	Amount of Waste.	Outlet.
Broken 3-in. pipe,	253 000 gals. per day	Following wall to river.
Blown 8-in. joint,	149 000 gals. per day	Underground to river.
Broken $\frac{5}{8}$-in. service,	121 000 gals. per day	Flowing into sewer.
Broken $\frac{3}{4}$-in. service,	100 000 gals. per day	Underground.
Broken $\frac{5}{8}$-in. service,	85 000 gals. per day	Flowing into sewer.
Broken $\frac{5}{8}$-in. service,	87 000 gals. per day	Flowing into sewer.
Blown 6-in. joint,	38 000 gals. per day	Flowing into sewer.
Split $\frac{5}{8}$-in. service,	30 000 gals. per day	Underground.
Broken $1\frac{1}{4}$-in. service,	35 000 gals. per day	Underground.
Split $\frac{3}{4}$-in. service,	27 000 gals. per day	Underground.
Hydrant not seated,	30 000 gals. per day	Underground.

One 10-in., one 8-in., two 4-in., and two 3-in. meters were found to be under-registering, some of them seriously. No case of unauthorized use of water was found.

* Division Engineer, Water Department, Boston, Mass.

The week-day average daily industrial consumption (including schools, armories, factories, power plants, gas works, dairies, sugar refineries, railways and Navy Yard) was noticeably large, amounting to 4 424 765 gals., or approximately 128 gals. per capita. Four customers only, viz., Navy Yard, B. & M. Ry., one sugar refinery and one dairy, were responsible for 3 832 000 gals. or more than three quarters of the whole. In one of these cases there is every reason to suppose that a large waste helps to swell the bill.

Allowing an unavoidable waste of 3 000 gals. per mile of pipe per day, the present domestic daily per capita consumption of the district, as determined by the survey, is 32 gals.

The method of work was essentially the same as that used successfully for many years in Boston, with the difference that the portable pitometer inserted in the pipe through a 1-in. corporation cock, supplanted the permanently located Deacon Meter, and gave greater flexibility of operation. The district, approximately one square mile in area, was divided into twelve sections, the largest of which contained about forty blocks. The average daily consumption of each section was determined by taking the mean of two 24-hour measurements, the flow into the section being through one pipe only, into which the pitometer was inserted and the section being completely isolated from the surrounding distribution system by the closing of all gates around its boundaries. If the minimum night rate was found to be more than one half the average daily rate, it was assumed that avoidable waste existed and the section was subdivided to further locate such waste. This work was done at night during the period of least draft; the flow into the entire section was first measured, then the area of the section was slowly decreased by cutting out block after block.

As the measurement was continuous, the record of the instrument showed the amount of water used in each block, and a leak of any considerable size was quickly apparent. To actually find the leak that it might be repaired, the usual methods were employed,— perhaps the most successful being the use of a steel rod driven down to the pipe at intervals of about 5 ft.; by listening with an aquaphone at the end of the rod, much unnecessary excavation was avoided.

OPERATION OF A TRUE SIPHON ON A MAIN SUPPLY PIPE.

BY WALLACE R. BRANN* AND CHARLES W. SHERMAN.†

[*November 10, 1920.*]

True siphons in water-works practice are of very rare occurrence, — so rare that the writers have not been able to find any published record of the operation of such a siphon. It may, therefore, be interesting to water-works men to learn of the conditions encountered in operating a siphon on a main gravity supply pipe.‡

A supply of water for Hallowell was originally obtained from the head waters of Cascade Brook, about 1.5 miles northwest of the city. Two small reservoirs were constructed on the brook, and a 6-in. pipe laid from the lower reservoir to two distribution reservoirs just west of the built-up portion of the city.

The intake in the reservoir is approximately 8 ft. below spillway level. The pipe leads from the reservoir across a valley perhaps 40 ft. lower, and then rises, crossing a ridge at a distance of about 6 000 ft. from the reservoir. The elevation of the surface here is approximately 9 ft. above the high-water level in the reservoir, and the pipe is about 3 ft. above high water. From this point the pipe descends sharply to the distribution reservoirs, which are about 41 ft. lower than the supply reservoir.

The portion of the ridge lying above the elevation of high water in the reservoir is 500 or 600 ft. in length, measured along the pipe, and it would have been necessary to excavate at least this length of trench in rock, to locate the pipe below the hydraulic grade line.

Hallowell is a city of about 3 000 population, located on the west bank of the Kennebec River, just south of Augusta. The water consumption is not definitely known, but probably approximates 200 000 to 225 000 gal. daily.

The drainage area from which the supply is obtained covers only about one quarter of a square mile, and the quantity to be obtained from it, particularly in dry years, is therefore somewhat less than the consumption of the city. Some years ago an emergency connection was made with

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* Superintendent of Water Works, Hallowell, Me.

† Of Metcalf & Eddy Consulting Engineers, Boston, Mass.

‡ Since the paper was written, the new (1920) edition of the American Civil Engineers Hand Book has been received, which contains the following:

"A siphon installed by George S. Pierson, M.Am.Soc.C.E., of 24-in. diameter cast-iron pipe about 2 900 ft. long with a 20-ft. lift, has been in use for many years, connecting a distant well with one near the pumping station at Kalamazoo, Mich.

"A 24-in. diameter spiral riveted pipe siphon installed by the writer [G. S. Williams] at Taughannock Falls, N. Y., in 1904, has an initial lift of 9 ft., a run of 411 ft., with a rise of 6 in. and a drop of 88 ft. to a water wheel which is supplied through it, and drives a lighting plant furnishing current to the village of Trumansburg. The wheel has a draft tube giving a further drop of 14 ft., and no difficulty has been encountered from accumulation of air when running, the operation head being from 90 to 93 ft."

the pipes of the Augusta Water District, and after a time the operation of the siphon became so unsatisfactory that the entire supply was taken from Augusta. This was the condition in the year 1918 (until December 15), during which year an average of 210 000 gal. per day was purchased from Augusta, at a price of 7c. per thousand gallons, the total bill for the year being $5 367.

Prior to its practical abandonment, the method of operating the siphon was as follows: Valves at the inlet and discharge ends of the supply pipe were closed; the air valve at the summit was opened, and a supply of water from a small reservoir 20 or 30 ft. higher in elevation was drawn through a 2-in. pipe into the 6-in. pipe, to charge the siphon. When all the accumulated air had been expelled at the summit, the air valve was closed and the supply cut off from the upper reservoir; the gates at the inlet and discharge ends of the pipe were opened, and the siphon would operate without attention until a sufficient quantity of air had accumulated at the summit to break the siphon. The efficiency of the siphon began to decrease almost immediately, and gradually fell off until the flow practically ceased. It was the custom to manipulate the valves at 7 and 11 A.M. and 4 and 7 P.M., and under this scheme the siphon was operated with a fair degree of success. The consumption of water at that time is not known, but was probably less than at present.

The connection with the Augusta supply was installed primarily to supplement the inadequate supply from Hallowell's own source. The 2-in. pipe, from which the supply for filling the pipe was obtained, finally gave out, and the siphon could not then be operated, and the whole supply was obtained from Augusta, as above noted. The annual expense of obtaining water in this way was so great that the question of replacing the 2-in. pipe or finding some other method of operating the siphon was raised, and Metcalf & Eddy, consulting engineers, of Boston, were asked to advise the water commissioners in this matter.

The development of the Hallowell water supply had already been made. The water was of excellent quality, but was running to waste for want of a method of utilization, while at the same time the city was paying considerable sums for water to supply this lack. The cost of excavating in rock to lower the pipe over the summit below the hydraulic grade line was practically prohibitive. It was suggested that if some automatic means could be provided by which air could be removed from the summit as it accumulated, there was no reason why the operation of the siphon should not be made continuous and the city's source of supply utilized to its full capacity. An electric-power line crossed the summit in close proximity to the pipe, so that electric power was readily available, and there was no reason to doubt the practicability of providing an automatically controlled air pump for the removal of the air. No definite information as to the quantity of air to be handled could be obtained. From the fact that the siphon had been operated with a fair degree of success

when operating the valves at intervals of four or five hours, it seemed obvious that the accumulation of air could not be very rapid. The matter was taken up with Mr. C. O. Rogers, engineer for the Charles J. Jager Company, of Boston, who suggested the following equipment for this installation:

1 Receiver 24 in. diameter by 36 in. length, of reinforced steel construction, with supporting cradles and 6-in. flanged yoke.
1 Water glass and fittings, for indicating water level in the float chamber.
1 Copper deposit float with necessary connections for the operation of float switch.
1 Triple pole float switch of the enclosed type.
1 Gardner compressor unit, 3 x 3½, air cooled, with extended motor base and belt and idler drive. Capacity of compressor, 8 cu. ft. of free air per minute.
1 1½ h.p. 3-phase motor, 1 800 r.p.m., for 220-volt current.

After some consideration, order was placed with the Jager Company, for this apparatus.

A vault 12 ft. long, 6 ft. 6 in. wide, and 8 ft. deep, was built enclosing the pipe at the summit, where a tee branch was set, turned up. The air tank or receiver was mounted upon this tee, and a small wooden building previously located over the air valve was placed over the entrance to the vault. Considerable rock excavation was involved in this construction. The total cost of the installation is estimated as follows:

Pumping equipment, including air tank, etc	$643
Vault, about	800
Installation and connection of apparatus, about	100
Total	$1 543
Say	$1 600

The apparatus was put in operation on December 15, 1918, and has been in practically continuous service ever since. The motor operating the pump was burned out some time later, due to a drop in voltage on the electric-power line, and through no fault of the apparatus. The operation is entirely automatic, and the siphon is maintained in continuous operation. It is, of course, necessary to throttle the valve at the discharge end of the supply pipe where it enters the distributing reservoir, in order to prevent breaking the siphon, due to the excessive drop in this leg of the siphon, and also to avoid depleting the reservoir too rapidly.

It is still necessary to obtain water from Augusta to supplement the inadequate supply from the local source, particularly at times when the consumption is high. During the year 1919 an average of 84 000 gal. per day was so obtained, at a cost of $2 146. During this same year the cost of electric power for operating the vacuum pump was $85, the price being 9c. per kw.-hr., and in addition the cost of electric lights for the vault was $9, making a total cost of electric current $94. If interest and depreciation on the investment be assumed at 7 per cent., or $112 per year,

the total cost of operating the siphon during 1919 was $206. Adding this sum to the cost of water purchased during that year, makes the total cost of the water supply $2 351, or $3 016 less than the cost for the year 1918.

A similar comparison for the first six months of 1920 is as follows:

Cost of water bought from Augusta (110 000 g.p.d.)	$1 396
Cost of electric current	66
Interest and depreciation	56
Total	$1 518 for 6 months

or $3 036 per year, — which indicates a saving of $2 331 for 1920 as compared with 1918.

When the apparatus was first installed, the pump operated only about once an hour. It was found, however, that at times when the water in the reservoir was comparatively low, much more air accumulated, and in July of this year the pump was found to be operating about once in five minutes. The difference in water level in the receiving tank, between the time of starting and stopping the pump, is about 6 in., corresponding to an accumulation of air of approximately 3 cu. ft.

It is probable that when the water in the reservoir is low, more air enters the pipe at the inlet end in solution or in suspension in the water, and it is also possible that some air is drawn in by vortex action. The period of low water in the reservoir also corresponds to the time of low ground water, when a greater amount of the pipe which is above the hydraulic grade line, and therefore subject to negative pressure, is above ground-water level. Under these circumstances more air would probably be drawn into the pipe, through joints, than when ground water is high.

The pump maintains a vacuum of approximately 21 or 22 in. of mercury, corresponding to about 24.5 ft. of water. The hydraulic grade line at the siphon is therefore about 24.5 ft. below the pipe at the summit of the siphon, and 20 or 21 ft. lower than the water in the reservoir.

Discussion.

Mr. Frank A. Barbour.* Some ten years ago a siphon was put in at Woburn, which connects some twenty-five driven wells with a well adjacent to the pumping station. I think the high point in the pipe line is perhaps ten or twelve feet above the hydraulic gradient. The siphon was laid on a rising gradient to a point immediately over where it dropped into the receiving well. At this point a tee was placed in the line, similar to that described by Mr. Sherman, and connected by 2-in. pipes to a steel tank in the station. Connected with this tank is an air compressor, reversed, operated by a Pelton wheel, driven by the city pressure, with discharge back into the well. This air pump was designed to start auto-

* Consulting Engineer, Boston, Mass.

matically, but since it only has to be operated about once or twice a day, the automatic attachment was disconnected. The siphon has worked successfully, so far as I know; it is 14-in. pipe, about 1 400 ft. long.

PAST-PRES. EDWIN C. BROOKS. The Cambridge Water Works had in operation a 30-in. cast-iron pipe line from Stony Brook reservoir to Fresh Pond, and near Fresh Pond there was a summit that was above the hydraulic gradient. After that pipe was laid for some time we had no apparent trouble from it. It seemed to work perfectly, and there was no accumulation of air, but gradually it commenced to fail and an investigation was made. The pipe ran along before it got to this summit covered rather light, not much over 3 ft. In investigating we dug up the joints along in this level stretch of street, and when those joints were uncovered, and we tried to drive them, it sounded like driving a loose hoop on a tub or barrel. The lead seemed to be loose in the joint, notwithstanding the fact that those joints probably had been faithfully driven.

The joint seemed to be loose in the bell, and the question occurred whether it was not possible that, there being a shallow cover there, and the water flowing through the long line of pipe and becoming warmer after standing in the pond or reservoir — it had not expanded the pipe, and then the chill of winter, the frost going down, had contracted the lead or contracted the pipe, so that these joints had gradually been compressed. But, anyway, for a long distance — I should say, roughly speaking, 500 or 600 ft. — the joints seemed to be quite loose, and were driven up. Part of the 30-in. line was supplanted by the 53-in. conduit, built by Mr. Coffin, so that that portion of the pipe has been out of use.

MR. RAYMOND F. BENNET.* Some twenty years ago, there was a 16-in. siphon in successful operation at Richmond, Ind. Possibly that is the one that Mr. Gardner Williams had a report of. Mr. Howard A. Dill, a member of this Association, could probably give information concerning it. I think it is still in use.

MR. D. A. DECROW.† In Auburn, N. Y., there was a 24-in. pipe laid, 9 000 ft. long, and used as a siphon. It had an elevation, I think, at the high point, of something like 9 ft. The original installation was intended to be laid at a grade, but they struck quicksand, and kept above it. This discharged some 6 or 7 million gal. a day. They installed a pumping station at the lake, but found it was not necessary to use it. They did, however, have to remove the air from the high point. There was no difficulty in delivering all the water needed. The pipe was laid in 1885.

MR. ROBERT SPURR WESTON.‡ Just by way of reference to this paper, I might say that some fifteen years ago I called special attention to the rubber rings to be used in a joint of this kind.

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* Contractor, Portland, Me.

† Of Worthington Pump and Machinery Company, New York.

‡ Consulting Engineer, Boston, Mass.

TOPICAL DISCUSSION.

Fire in Coal Piles.

President Macksey. Is there anybody here who has had experience in applying water to extinguish a fire in a coal pile?

Mr. Harry A. Burnham.* Once in a while the members of the Mutual companies have that problem to contend with. It is usually the case that the coal has been in the pile a long time, and that the fire is deep down at the bottom. We find about the only satisfactory way to handle that is to shovel it out. That is attended with some hazard, but if the hose is kept ready you can usually prevent the fire from getting away. The fire can be located by sinking 1-in. pipes tapped at the lower ends in which a thermometer can be lowered. The heated part should then be removed by digging, using as many men as can be worked to advantage. The hot coal should be drenched as it is exposed, so permitting the men to dig in until all the hot coal has been removed.

Mr. Stephen H. Taylor.† I think Mr. Burnham perhaps will back me up when I say that some of the coal piles are piped to the bottom with perforated pipe so that water can be gotten into them.

Mr. Burnham. There have been cases where that has been tried.

Mr. Taylor. It has been successful, hasn't it?

Mr. Burnham. Fairly so. They use that pipe at times for determining the temperature near the bottom of the pile, by dropping thermometers down through the pipe. In that case you know the condition of the pile before the fire occurs and can shovel the coal out before there is any fire. When this method is used a 2-in. pointed pipe, with 3 or 4 ft. of its length perforated with $\frac{3}{8}$-in. holes, is driven into the pile and water forced into it through a hose line. Care should be taken that the men are not allowed to stand near when the water is applied, as there is some possibility of explosion due to formation of steam.

Mr. Richard D. Chase.‡ About two years ago, in Superior, Wis., I saw a large coal pile with fire running through it in all directions. The pile may have covered an acre or more and was from 15 to 20 ft. high. They have had much experience in Superior with coal fires, for there the coal is accumulated during the summer, stored on the piers and shipped out during the winter. It is evident that they had no better way than overhauling and wetting down. There was a permanent wrought-iron pipe alongside the loading track, temporarily connected to the nearest shore

* Inspector and Engineer, Associated Factory Fire Insurance Company.
† Assistant Superintendent, Water Works, New Bedford, Mass.
‡ New Bedford, Mass.

hydrant. Hose lines were taken from the pipe where needed. The coal was being dug out with a steam shovel, quenched with water when necessary, and loaded into cars for shipment. The fire did not come to the surface, and as it was broken down only a small percentage showed signs of fire; this occurring in veins, only. The action was perhaps more like coking than burning.

MR. WILLIAM F. SULLIVAN.* Some of the experts on coal-pocket fires now advise against the use of water, but are using some sort of a chemical preparation, bicarbonate of soda, probably. I have seen a device or nozzle advertised which is connected to a hose, and this nozzle is driven to the bottom, from which the water finds its way through the pile.

VIBRATION IN HOSE, PRODUCING HEAT.

MR. CHARLES W. SHERMAN.† Mr. Sullivan's mention of an unusual device calls to my mind a clipping which was shown me a few days ago, — a new cotton hose was being tested with a fire stream and it burst into flames. The clipping stated that some expert had determined that the cause was the friction of the water through the hose.

MR. BURNHAM. My impression of the investigation which was made is that the hose was used in connection with a pumping engine which caused a great deal of vibration of the hose, it being run at high pressure, and the outer and inner jackets of the covering of the hose were supposed to have chafed on each other, to the extent that the jacketing was injured by the heat.

MR. TAYLOR. I talked with one of the engineers of the New England Bureau, who conducted the test after this fire that Mr. Sherman speaks of, and he said that they did produce that effect by running with a throttled valve. This did not furnish water enough to completely fill the hose and caused vibration and friction between the rubber lining and cover. The heating was very noticeable and increased, until finally it smoked and burst into flames. This was done after the fire to see if the burning could be reproduced.

It has been found that this effect can be produced on any brand of hose under similar conditions.

MR. BURNHAM. I might say that there is a great deal of vibration in the hose if the pump does not act smoothly, and it is very conceivable if you operate under conditions of that kind, for a long enough period, that you can produce heat.

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* Engineer and Superintendent, Pennichuck Water Works, Nashua, N. H.
† Of Metcalf & Eddy, Boston, Mass.

RECENT PROGRESS IN THE STANDARDIZATION OF THREADS FOR FIRE-HOSE COUPLINGS AND FITTINGS.

F. M. GRISWOLD.*

[*September 9, 1920.*]

GENTLEMEN, —

Assuming that you will be interested to be advised as to the progress being made in the standardization of threads for public fire-hose couplings and fittings, it affords me pleasure to present to you the following additional facts as in evidence of the widespread and growing interest in the matter shown by many public officials and municipalities in their acceptance and adoption of the National Standard Hose couplings, as per the specifications approved by this Association, which, as you doubtless will recall, provide for a coupling of $3\frac{1}{16}$ in. outside diameter over the male end thread, with $7\frac{1}{2}$ threads to the inch, to conform to the dimensions of which it is practicable to readily convert other screw couplings to serviceable interchange with the standard when the range of diameters fall within the limits of from 3 in. to that of $3\frac{3}{32}$ in., with threads of either 7, $7\frac{1}{2}$, or 8 to the inch.

The process of conversion is remarkably simple and inexpensive, as has been demonstrated when such conversion has been secured by the use of the special tools and devices perfected through the efforts of the "Committee on Fire Protection and Engineering Standards" of the National Board of Fire Underwriters.

A detailed and illustrated description of these tools was presented (in pamphlet form) to this Association when last I had the pleasure of bringing the matter to your attention; some 14 000 copies of this pamphlet have been distributed broadcast throughout this country, resulting in an encouraging awakening of public interest, as has been evidenced by the many inquiries in relation to the matter received from water-works and fire department officials, state fire marshals, fire insurance companies, manufacturers of fire apparatus, and fire underwriters' inspection bureaus.

In addition to the results attained as set forth in the text of the pamphlet referred to, addresses and demonstrations have been made at conventions of state firemen's associations. Circular letters were also sent to all state fire marshals and insurance commissioners and to all fire chiefs in cities of over 20 000 population, with a view to arousing the widest possible publicity and soliciting active coöperation forwarding the work of standardization of fire-hose threads in the territory under jurisdiction and control.

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* General Inspector, Home Insurance Company.

The Committee of the National Board of Fire Underwriters plans to make other exhibits and conduct further demonstrations in various parts of the country, in order to stimulate state-wide activity in securing complete standardization in the near future.

That these activities have been productive of very substantial results is evidenced by the fact that one or more sets of standardization tools have been purchased by the underwriters' inspection bureau or the state fire marshal's office having jurisdiction in Connecticut, Illinois, Indiana, Kentucky, Michigan, Minnesota, New Jersey, Pennsylvania, Tennessee, and West Virginia, preparatory to starting the work of standardization in their respective states; and it is gratifying to be able to record the fact that the work of standardization recently accomplished in the state of Michigan by the Michigan Inspection Bureau, in coöperation with a committee of the Michigan State Firemen's Association and the state fire marshal's office, is not only typical of the movement being initiated in several other states but is remarkable at the same time in its demonstration of the practical results which may be accomplished through the use of these standardization tools by those not specially trained in their operation, it being a fact that with one set of these tools in charge of an engineer provided with an auto runabout, the first week's work in Michigan resulted in the complete standardization of all hydrant hose outlets, hose couplings, and special fittings in four municipalities. It is now planned to place at least two men in that field, each in charge of two sets of tools which are to be available for continuous operation in order to assure complete standardization throughout the state within the next two years.

It will interest you to be advised that since this initial effort the number of towns in the state of Michigan which have been standardized by means of these special tools and devices has been increased to fifteen by the 3d of the present month, as per advices this day at hand, and that the good work is being actively progressed with most gratifying results.

The towns in which the work of standardization has been completed, together with information as to their population, diameter and pitch of thread, number of hydrants treated and number of parts of apparatus re-cut, is as follows:

Town.	Population.	Diameter.	Pitch.	Hydrants.	Parts
Berrien Springs.....	900	3.049 3.071	7½	32	64
Cassopolis.....	1 600	3.092 3.148	8	50	100
Constantine.....	1 500	3.014 3.064	7	47	156
Decatur.....	1 500	2.981 2.992	7½–8	40	218
Dowagiac.....	5 500	3.000	8	106	643
Lawton.....	1 100	3.007 3.060	7½	23	47

Town.	Population.	Diameter.	Pitch.	Hydrants.	Parts.
Marcellus	1 100	3.061	8	40	145
		3.076			
Mendon	1 000	3.003	8	18	110
Mount Clemens	10 000	3.003	7½-8	250	2 153
Niles	7 000	3.036	8	206	515
		3.094			
Paw Paw	2 000	3.072	8	40	132
		3.082			
Schoolcraft	800	3.000	7½	34	112
Sturgis	6 100	2.994	8	110	618
		3.031			
Three Rivers	7 000	3.083	8	160	540
		3.093			
Vicksburg	2 000	3.000	7	48	301
	49 100			1 204	5 859

Particular attention is called to the fact that the work of conversion carried out in each of the towns tabulated was performed on couplings, hydrant outlets, and other utilities showing variations from the National Standard dimensions of $3\frac{1}{16}$ in. over male thread ranging from 2.981 in. to 3.148 in. and covering pitch of thread of 7, $7\frac{1}{2}$, and 8 threads to the inch, in two instances both $7\frac{1}{2}$ and 8 threads being found in the respective equipments.

The conditions as presented in the above tabulation brought into play and practical test every function of these conversion tools save that of reduction of thread on male ends of excess diameter, it being necessary in each instance to expand the male end, recut its thread and tap-out the female member to standard dimensions, the total operations covering nearly 6 000 separate items in recutting the various parts, all of which was accomplished with such remarkable and gratifying results as to encourage the hope that this demonstration of practical results in the conversion of such public utilities may serve to convince the skeptical and spur the progressive official having jurisdiction, to push the good work to an early completion in all sections of this country where non-conformity to the National Standard Hose coupling may still be in evidence.

This brief résumé of recent progress in the work of standardization, added to that heretofore reported, certainly encourages the hope of its ultimate success in all sections of this country, at no distant day, if this Association and all other organizations interested in securing uniformity in these highly essential public utilities will more earnestly and energetically coöperate in carrying out the work of complete accomplishment, and I therefore appeal to the members of this Association to prove their faith in this standard, approved and sponsored by this Association more than seven years ago, by bringing the equipment of their several cities and towns into conformity to the National Standard, to the end that the vested interests of the community may be more surely safeguarded and the jeopardy of loss of human life by fire be thereby minimized.

MODERN PUMPING STATION DESIGN AND OPERATION.

REEVES J. NEWSOM.*

[*September 10, 1930.*]

It has been necessary within the last two years, in order to keep abreast of the times and to get proper efficiency in operation, to make three typical changes in our pumping station equipment. A motor-driven centrifugal pump installed in 1912 in the Glen Lewis station had been so outgrown by the progress in design of this type of pump that it was economical to junk the equipment and replace it with new.

The Walden Pond station, equipped with a steam-driven pump, became uneconomical and impractical to operate, and unable, because of its peculiar situation and the difficulty in obtaining men for its operation, to supply the amount of water needed; and it has been supplanted by a new station in a different location, with electric motor-driven centrifugal equipment.

In the main pumping station, which pumps daily into the mains and equalizing reservoir, the coal situation has become so involved that we have found it necessary to change to oil as fuel for the boilers.

The Glen Lewis equipment consisted of a centrifugal pump delivering about 15 million gallons per day against a 20-ft. head driven by a 100 h.p. synchronous motor with suitable switchboard and starter. The priming pump was of the ordinary reciprocating type, belt driven from a small motor. There was no water meter installed with this pump, and for six years it was run without any idea of the efficiency at which it was operating.

In 1918 the writer ran a series of tests, using a Petot tube meter for measuring the water, and found that at rates from $12\frac{3}{4}$ millions to $16\frac{3}{4}$ millions per day against heads ranging from 10.9 ft. to 27 ft. the combined efficiency of the unit varied between 26 per cent. and 47 per cent. This unit has now been replaced by a pump which delivers about 17 million gallons per day against a 20-ft. head driven by a 75 h.p. induction motor at 500 r.p.m. The auxiliary equipment is in all respects identical with that at the Hawkes Pond station, as is also the method of operation, which will be described later. This pumping unit at the time of its acceptance tests showed a combined efficiency of 74.5 per cent.

The Walden Pond station, built in 1902, received water into the suction well through a canal about three quarters of a mile in length. When in operation two men were required at all times to attend to the screens at the end of the canal and to control the flow of water. The equipment

* Commissioner of Water Supply, Lynn, Mass.

in the station consisted of a cross-compound Corliss engine, the piston rods of which were extended through the cylinders and the pump attached beyond. Because of the arrangement of suction canal, discharge lines, etc., water which needed to be lifted from one pond to another only 20 ft. higher was actually being pumped against a 45-ft. head.

This station was used to pump water which flowed by gravity from the Saugus River to Hawkes Pond during the winter and spring months. Due to the necessity of getting together a force of engineers and firemen, it could only be operated when a steady run of water of at least two or three months' duration was assured, and to-day, of course, it would be impossible to get together a force of men for a short term job of that kind. Short flood flows in the river could never be utilized, and the consumption of water by the city demands more than the steady spring flows will yield.

All these difficulties were overcome by building a new station on the shore of one pond, at a point only 500 ft. from the other, and equipping the station with a motor-driven centrifugal unit. This location reduced the lift to 23 ft., including piping losses, and the starting and stopping of the plant is so simple that all flood flows can be taken advantage of, even though they are of only one day's duration. This has practically doubled the value of the Saugus River as a source of supply.

The equipment in the new station consists of a centrifugal pump capable of delivering 21 million gallons per day against a 23-ft. head, and is driven by a 100-h.p. induction motor at 450 r.p.m. This motor, as well as the one at the Glen Lewis station, is wound to use 4 000-volt, Y-connected current direct from the transmission line without a transformer.

The auxiliary equipment in both stations includes a two-panel switchboard, a water meter, and a priming unit, and in the Hawkes station a $\frac{1}{4}$-in. mesh copper screen of the revolving endless-chain type, with suitable washing pan and hot- and cold-water connections for cleaning off dirt and ice.

The switchboards contain both electrical and water instruments, consisting of the following: voltmeter, ammeter, oil switch of the remote control type, lighting and priming pump switches, overload release, under voltage release, inverse time limit over load release, the power company's watt-hour meter, and a curve drawing wattmeter; a clock, indicating discharge and suction gages, and recording discharge and suction gages. On the back of the panel and wired in series with the under voltage release is mounted a diaphragm suction regulator which shuts down the pump just before it loses water. The water meters are indicating, recording, integrating instruments, actuated by Petot tubes.

The priming pumps are novel adaptations of a direct-connected motor-driven hydro-turbine vacuum pump, and, complete, occupy a space only 20 in. by 40 in. They are so compact that they are tucked under the outboard bearings of the pumps, and in general appearance are a part of the big units and add practically no space to the area which they cover.

The Hawkes Pond unit showed on its acceptance test an over-all efficiency of 77 per cent.

These two motor-driven installations are on the supply system where absolutely continuous operation is not essential, and we are able, in view of this fact and the safety devices which are provided, to operate them twenty-four hours per day for weeks at a time, practically without attendance. The only labor involved is the daily changing of charts and reading of meters, and the occasional supplying of a small amount of oil to the bearings. This is done at both stations by the patrolman on the respective parts of the reservoir system, so that there is no labor chargeable to the operation of the stations.

The Walnut Street station is equipped with a 15-million-gallon-per day turbine-driven centrifugal pump, and two reciprocating crank and flywheel pumps, 10 million and 5 million gallons per day capacity, respectively, power for which is furnished by two 175-h.p. boilers. There is also a motor-driven centrifugal auxiliary pump of $3\frac{3}{4}$ millions per day capacity, for which we purchase power from the local electric light company. As our consumption is about 9 million gallons per day, it is essential that at least one boiler be in operation at all times in addition to the electric unit, and ordinarily all the pumping is done by steam, using both boilers.

The coal problem has become very serious in two ways. At times coal is scarcely obtainable, and last winter for several weeks we had to depend on trucks coming through the deep snows from a city twenty miles distant, to keep our pumps going. Then, too, the quality of the coal now on the market has made its use very uneconomical. The station duty has dropped as much as 30 per cent. at times, and in order to keep up steam there has had to be wasted, unburned, through the ash pit, 18 per cent. to 20 per cent. on the average, and, at times, as high as 28 per cent., of the coal fired. Combined with these facts has been the ever-rising price of coal from around $4.00 per ton to $16.50 at the present time.

We have made a contract for oil at the equivalent of about $9 per ton for coal, and the price is guaranteed for two and one-half years, and the delivery of the oil for five years. This contract is backed by a $10 000 bond, which is two thirds of the cost of the oil-burning apparatus, and the amount to be saved is such that if the oil company delivers oil for only a few months we can change back to coal without loss.

The oil situation appears to be pretty stable, however, when it is remembered that enormous royalties are paid to the Mexican government on the output of oil, and it is, therefore, vitally interested in keeping them in operation; and further, any interference with the oil output would not be tolerated by the British and American navies. The company who furnishes the oil into trucks from storage tanks in Chelsea, Mass., owns also the wells, the pipe lines, and tank steamers which bring it to this country, so that transportation difficulties would seem to be minimized.

The oil-burning apparatus which is being installed consists of three

principal elements, the storage tank, the combined pump and heater, and the burners, with connecting piping and auxiliaries.

The storage tank is of reinforced concrete, built in two separate compartments with a total capacity of 35 000 gal., or about three weeks' supply. A suction pipe comes from each compartment of the tank and runs to the pump inside the boiler room. These pipes are surrounded near the end by steam jackets which heat the heavy fuel oil so that it will flow. Pipes extending to the bottom enter the tank at the same points, to which ejectors can be attached for removing water which may collect from time to time.

The pump to which the suction pipes are attached is of the double duplex direct-acting type, mounted above the heater which is cylindrical in shape, the whole thing being a small, compact unit. The heater is constructed like a surface condenser, the steam being inside the tubes and the oil flowing around them. In this heater the temperature of the oil is raised to about 130 degrees Fahr.

From the heater the oil is pumped to the boiler front, where it passes through an auxiliary heater composed of another steam jacketed section of pipe which is used to heat the oil beyond the pump when the boilers have been banked, or when for any reason the main heater does not function properly. The piping is so arranged that all exhaust steam from the heaters and pump is returned to the boilers.

The oil then passes through a regulator and to the burners, where it is atomized by steam and mixed with air. The burners are placed just below the location of the coal grates, the pipes coming in through the ash doors, which are entirely bricked up except for the requisite air slots.

The regulator is actuated by changes in steam pressure, and controls the flow of oil to the burners. The supply of air is controlled by the position of the chimney drafts. It is possible to obtain a regulator which will also control the air, but a centrifugal pump load is so steady that practically no change is required in the amount of air needed, once it has been set to meet the atmospheric conditions for the day's run, and the complication of such a regulator is not, therefore, justified in our installation.

We use both boilers ordinarily to carry the load, and, to prevent its unequal distribution and the overloading of either of the boilers, steam-flow meters are being installed to show the respective outputs.

The dangers in the use of oil are two, — having too hot a fire and having the fire too concentrated. The limit to which an oil fire can be forced is usually beyond the safety point of the boiler, and so the output must be watched. If the burners are too close to the boilers the flame may be so concentrated that the rivets in the shell will melt. A boiler setting built especially for oil is usually very high, but a coal installation can in most cases be adapted to oil by removing the grates and putting the burners in the top of the ash pits.

The principal advantages which will in our case be derived from the use of oil are as follows:

1. Oil is cheaper than coal.
2. It can be burned more efficiently than coal.
3. Greater boiler capacity can be developed.
4. Coal and ash handling charges will be eliminated.
5. Variation in quality will be minimized.
6. Banking of fires can be done very much more economically.
7. Neater and cleaner and better working conditions will be obtained.

The burning of oil seems to solve our problem in this station, temporarily, at least, and perhaps until such time as the eventual solution, the development of available water power, will be consummated.

Under favorable conditions, steam power can be developed and used more cheaply in Lynn than electrical power; but in the case of the two stations mentioned above, which are situated on the supply system, and which are operated only a part of the time, the difficulty in obtaining labor, and the higher fixed charges on steam-driven equipment, more than offset the higher cost of operating by electricity.

CLEANING AND PAINTING STANDPIPES.

BY CHARLES W. SHERMAN.*

[*December 8, 1920.*]

What I have to say relates not so much to cleaning and painting standpipes as to the effect of corrosion upon a standpipe which went without cleaning and painting inside, for a period of twenty-nine years. This is a longer time than most of us would dare to leave such a structure without examination and cleaning, but in this particular case the difficulties of throwing the standpipe out of service were so great that the water commissioners preferred to take what risk there was, rather than to attempt to operate the works by direct pressure for a sufficient period to clean and paint the tank.

This standpipe is at Needham, Mass., and was built in 1891, or twenty-nine years ago, by E. Hodge & Company, East Boston. It was designed by one of our old members, Mr. Louis E. Hawes. It is 25 ft. in diameter and 85 ft. high.

At the time it was built, the standpipe was painted inside by the makers, but had no further treatment on the interior until this year, when it was thoroughly cleaned by hammering and wire brushing, and well painted with red-lead paint.

The original construction included a riser pipe, extending to about 3 ft. below the top of the tank, supported by ties of wrought-iron rods, connected to the side of the tank. During the severe weather of last winter, the ice tore away the ties, and the riser pipe collapsed.

An additional standpipe having been provided two or three years ago, it was practicable to throw this tank out of service long enough to remove the ruins of the riser, and to clean and paint the tank. I was fortunate enough to have opportunity to examine the condition after the interior had been painted, and obtained a couple of photographs which show in an interesting manner the results of corrosion during the twenty-nine year period.

The most significant photograph, Fig. 1, shows one of the plates of the lowest ring near one of the vertical joints. The pittings are very noticeable in the photograph. Most of them are from $\frac{3}{4}$ in. to 1 in. across, and of a depth a little over $\frac{1}{16}$ in. Some have a depth approximating $\frac{1}{8}$ in., and extend in a vertical direction as much as 6 in., or even more in some cases.

It is very interesting to note the groove immediately adjoining the vertical joint. It seems probable that this results from the bending of the

* Of Metcalf & Eddy, Consulting Engineers, Boston, Mass.

plate, resulting from expansion and contraction and the greater stiffness of the lapped joint. This bending, while doubtless very slight, apparently has been sufficient to throw off scale as fast as it formed, and thus to expose fresh metal to the action of the water, in this way causing more continuous corrosion than at any other point.

FIG. 1. SIDE PLATES OF STANDPIPE AT NEEDHAM, MASS., SHOWING EFFECTS OF CORROSION.

This explanation seems to be substantiated by the fact that a similar horizontal groove is to be noticed just above the edge of the holding-down brackets, where there must have been a slight amount of bending, resulting from the swaying of the standpipe in a heavy wind.

I did not have opportunity to examine the upper plates closely, but, as far as I could tell from the floor, it appeared that the corrosion in the upper part of the tank was very much less; in fact, almost none was noticeable in the upper 20 ft. or so, and it gradually increased in amount to the bottom ring of side plates.

The bottom, or floor plate, of the tank seemed to be substantially free from corrosion, probably on account of the protection afforded by the sediment which collected in the tank.

I have not made any computations of the loss of strength resulting from the pitting, but it seems probable that the reduction in area in the plates of the lowest ring, which were originally $\frac{3}{4}$ in. thick, is no greater

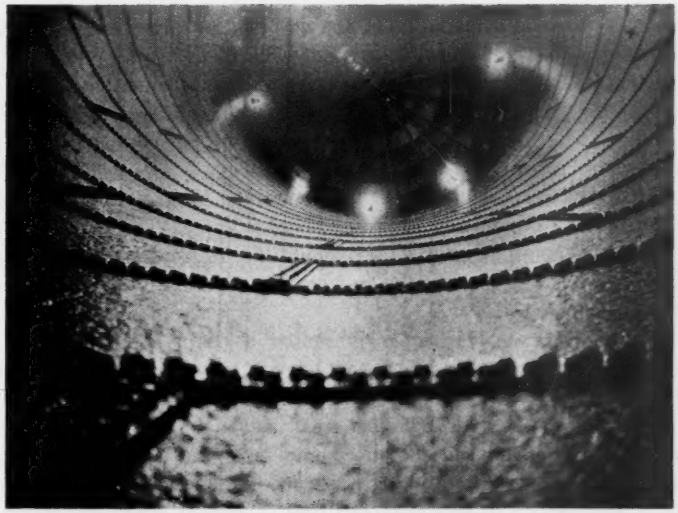

FIG. 2. INTERIOR OF NEEDHAM STANDPIPE, LOOKING UPWARD.

than that due to the rivet holes in the riveted joint, and that the factor of safety of the tank has not been materially reduced by such corrosion as has been suffered up to this time.

I should hesitate to quote this experience as a reason for leaving a metal standpipe unpainted for a long period. Doubtless the fact that this particular tank was of wrought iron had much to do with the fact that the damage was not more serious, and very probably, also, the character of the water was an item of importance.

The red-lead paint has the appearance of being very well applied, and will, I believe, adequately protect the tank for a considerable period. I should not advocate, however, leaving it without examination for a longer period than three or four years, particularly as additional corrosion at the points where the thickness is already reduced might seriously affect the safety of the tank.

Discussion.

Mr. Reeves J. Newsom.* I should like to ask Mr. Sherman how the average height of water in that standpipe compared with the fact that the top 20 ft. was not pitted as badly as the rest.

Mr. Sherman. I can't tell very positively, not having an intimate knowledge of the operation of the works, but it doubtless was the fact that the upper plates were alternately dry and wet. Certainly the water occasionally slopped over the tank, and also it must have been down 20 ft. or more below the top, from time to time. The fact remains, however, that the pitting was progressive as you went up to a point something like 20 ft. below the top.

Mr. Samuel E. Killam.† Have you any theory as to why the axis of the pits is vertical instead of horizontal?

Mr. Sherman. I imagine it has something to do with the rolling of the plates, but I don't know anything about it.

Mr. Morrison Merrill.‡ I should like to ask Mr. Sherman if he will tell us what he considers the best compound to use in painting a large standpipe on the inside.

Mr. Sherman. The paper presented a couple of years ago was designed to bring out experience in that line and try to find out how different paints had acted. Of course the differences in the character of the water and the exposure of the tank have a great deal to do with the case. Probably still more depends on the thoroughness of the cleaning of the tank before it is painted. But, taking it by and large, and for average conditions, I was unable to find anything that offered as promising results or that had satisfied as well, where I could get information, as red lead.

Mr. Merrill. I might say for the benefit of the members that I had a little experience, a year ago this summer, with a standpipe 40 ft. in diameter and 60 ft. high, of practically the same construction as this standpipe we have seen illustrated on the screen. It was five years since that had been painted. There was 8 in. of sediment in the bottom, — mud, iron rust, and one thing and another. The plates up to 30 ft. were badly corroded and badly pitted; above that they were practically as good as the day they were put in. The standpipe was cleaned up to 30 ft. twelve years ago; it had been painted but one coat of paint from that time until a year ago this summer, when it was painted with two coats of red lead. At that time it was thoroughly wire-brushed and cleaned, dried out and painted. When the first coat was dry we put on a second coat, and thirty-six hours after the second coat was finished we put the water into the standpipe. I opened that standpipe the twelfth day of October just past, and found that the paint is just as hard or harder than the iron itself, with the

* Water Commissioner, Lynn, Mass.
† Superintendent, Metropolitan Water Works.
‡ Superintendent, Water and Sewer Department, Wakefield, Mass

exception of one or two places where the iron rust was not wholly taken off and the paint did not get a good grip on the iron itself. That standpipe is in Wakefield.

MR. H. K. BARROWS * (*read by the Secretary*).

MEMORANDUM ON COST OF CLEANING AND PAINTING STEEL STANDPIPES.

Tanks at Fall River.

These are four in number, of the following dimensions:

Townsend Hill, 1 tank, 73 ft. in diameter by 37 ft. high.
Bedford Street, 2 tanks, each 65 ft. in diameter by 56 ft. high.
Haskell Hill, 1 tank, 65 ft. in diameter by 55 ft. high.

The total area of surface, including outside and inside of tanks and bottom, is about 99 300 sq. ft.

In 1915 the four tanks were cleaned by scraping, and painted inside, bottom, and outside two coats of Detroit graphite paint.

Paint, furnished by the city, cost	$1 167.98
Labor cleaning and painting, by contract, cost	1 036.80
Total	$2 204.78

Or about $22.20 per 1 000 sq. ft. of surface.

In 1919 the four tanks were cleaned by scraping, and painted inside, bottom, and outside one coat of Detroit graphite paint.

Paint, furnished by city, at cost of	$1 320.25
Labor of cleaning and painting, day work, cost	896.00
Total	$2 216.25

Or about $22.30 per 1 000 sq. ft.

Note that the cost per 1 000 sq. ft. was almost identical in 1915 and 1919, but in the former case included two coats of paint and in the latter case but one coat.

Standpipe at Gardner State Colony, Gardner, Mass.

This is 25 ft. diameter by 82 ft. high, with conical roof 20 ft. higher. It was cleaned by scraping, and painted in 1916, two coats inside and outside, of red-lead paint, —"Government formula," — at a total cost of $458, the state purchasing the paint and contracting for labor.

The total area covered was about 15 200 sq. ft. of surface, or at the rate of about $30 per 1 000 sq. ft.

MR. HENRY A. SYMONDS.† As an illustration of the different action of waters on the interior of steel tanks, I will mention two tanks recently cleaned and painted.

* Consulting Engineer and Assoc. Professor Hydraulic Engineering, Mass. Institute of Technology.
† Consulting Engineer, Boston, Mass.

The first tank, located on Cape Cod, was painted by the manufacturers when built, and repainted in about four years. When emptied this tank was found to be coated by hard scale which had to be chipped off with cold chisels.

In the second tank, located about thirty miles south of Boston, in place of the hard scale and tubercles appeared a soft, pasty coating which could almost be scraped off by the hand. The second was not painted for approximately two years after the first, but was in much better condition on the inside.

The waters were in both cases from well supplies, and very similar in their analysis, some elements, of course, being different on the Cape than farther inland. Both waters were very soft.

Within the last eight years several tanks in eastern Massachusetts have been painted with a compound which seemed to be a mixture of tar and some other materials, and was known as Main's Hot-coat. In several cases this has shown remarkably good results, and after several years there has seemed to be no material deterioration in the quality of the paint. In one case large scales came off during the second winter, but it was found that this was due to having imperfectly cleaned the tank, as the interior of the scales which came off were coated with a film of rust.

One of the dangers in using a heavy coat of this kind is that if it does not prove satisfactory, it is very difficult to remove, and proved the case in the tank cited.

From the summary of opinions by those best able to judge, I am convinced that red lead, for a first coat at least, proves about the most satisfactory of any form of paint which has been used for steel water tanks.

There is, however, a great deal to the question of painting besides the character of the paint. Perfect cleaning and the method of application are perhaps as important as the quality of the paint itself.

The study of the inside of some tanks has shown that with the ordinary painting more or less thick bodies of paint are left upon the surface of the metal. In many of these cases it will be found that water is contained under the paint, and usually more or less pitting has occurred at these points.

The secret of first-class steel tank painting is to *be sure of a clean surface* and *rub the paint out to a uniformly thin film*, which will become hard and adhere to the steel rigidly.

FIRST REPORT TO THE NEW ENGLAND WATER WORKS ASSOCIATION OF THE COMMITTEE ON UNIFORM ACCOUNTING.

(For Municipal Water Works Especially.)

[*September 9, 1920.*]

(Compiled for the Committee by A. R. Hathaway.)

To the New England Water Works Association,
in Annual Convention Assembled at
Holyoke, Mass.

Gentlemen, — Your Committee on Uniform Accounting, after many abortive attempts and futile struggles to do something to merit their appointment, beg leave to submit the following preliminary report, with its accompanying indicated arrangement for a simple but comprehensive scheme of modern accounting requirements, for possible approval and later adoption by water utilities by recommendation of the Association.

At the annual convention of the Association, held in September of 1916 at Portland, Me., there was read and discussed a very able paper submitted by Mr. Edwin L. Pride, certified public accountant, of Boston, on the subject of "Water-Works Accounting"; and as a result of this paper and discussion of the subject it was voted that the President of the Association appoint a committee to study the subject and submit recommendations in the matter, and that in such study the committee take into account available previous investigations of the subject made by other water works associations, by the Washington Bureau of the Census, and by the various public utility commissions of the country. At the outset this certainly appeared to be "some stunt"!

The President of the Association subsequently appointed the following persons to serve as such committee, viz., Mr. Albert L. Sawyer, Haverhill, Mass., chairman; Mr. Walter P. Schwabe, Thompsonville, Conn.; Mr. Samuel H. MacKenzie, Southington, Conn.; Mr. Edwin L. Pride, Boston, Mass.; Mr. Alfred R. Hathaway, Springfield, Mass.

Many causes have contributed since then to prevent any tangible headway being made by your committee, although individual members have more or less been accumulating facts and material along this line for possible concentration when conditions might be favorable; and then the World War and its attendant incidental responsibilities for everybody

made it almost impracticable to meet together as a committee or to have needful conferences. As Irvin Cobb recently said, regarding certain ideas and material he wanted to use in one of his articles, the darned things wouldn't jell!

With these preliminaries out of the way we will proceed to the main subject; and your committee would call attention at this time to the following pertinent facts appearing from a study of the matter, and which in our opinion cannot be gainsaid by thinking men of to-day.

Firstly. Every water-works enterprise at the present time serving the public (both small and greater) — whether such enterprise be privately owned and operated or be municipally owned and operated — is now universally classed as a "*public utility*" (along with gas and electric lighting plants, steam and electric railroads, telephone systems, etc.), and as such should be governed by the same fundamental methods of economic operation and control as all other public utilities. The only persons pretending to disagree are the politicians and those who do not *think.*

Secondly. In nearly every one of the United States during recent years there has been created, by legislative enactment and by the will of the people served, some form of a "public utility commission," or similar body, for the purpose of exercising certain proper control and direction over its "public utilities," and for the furnishing of needed and just protection to both the utilities and to the public which they serve.

Thirdly. Many of these public utility commissions, or public service commissions, have by law formulated and prescribed uniform accounting systems and classifications of accounts for the *privately owned* and operated *water works* and other utilities under their control; and in a number of the states such uniform accounting is prescribed for and required of the *municipally owned and operated water utilities* as well. (*Why not?*)

To the question as to the need of uniformity and improvement in the accounting of the municipal water utilities of to-day, the following should be considered sufficient in reply.

It is known that all private water utilities are obliged to follow well-defined methods and accounting practice, in order not only to meet requirements of the various public utility commissions but to meet requirements of the stockholders (the owners) in order that their invested interests may yield proper returns and at the same time conserve and keep protected their property for future operations.

Should the ownership of such utility by a municipality be just cause for ignoring the needs and methods provided in the case of private ownership? And how does such change of owners effect any change in the status of such utilities before the public served?

In perusing the annual reports received by one *municipal water works* (something like 250, maybe) we find some sort of record of the total *cash* received and expended during the year past (in numerous kinds of classification), but rarely do we find a simple, informing *balance sheet* of assets and liabilities, and of earnings and expenditures *accrued*, so that the financial standing of that utility can be readily determined without an exhaustive investigation by trained and practical accounting experts!

Listen to this extract from comment by the editor of a prominent public-service publication in this country, in the matter of an investigation made a few years ago of a certain public utility owned and operated by one of our large western cities. He states that this plant, " while claiming profits of from $100 000 to $200 000 two or three years ago, under the limelight of an official investigation turned up a deficit of $58 000 for the year, and that excluded part of the taxes. The investigation was made by engineers employed by the administration itself. . . . When the engineers . . . made their report . . . they stated, ' The delay in rendering this report and the almost inexplicable length of time it has taken to prepare the statements herein must be entirely attributed to the chaotic conditions of the bookkeeping records.' . . ." The editor goes on to say that " the engineers gave about seventy pages in their report to corrections of errors found in the plant's records. This system of bookkeeping is not confined to . . . ; *it is common to municipal ownership, with some fine exceptions.* . . ."

Of course this was a flagrant and prominent case, but the illustration of the common need of to-day, in lesser or greater degree, is certainly present.

The coming of the various forms of income taxes, imposed by governments, has startlingly shown the small storekeeper, as well as many larger merchants, the immediate need of better accounting (or in some instances the need of *some* accounting) in order that their true income (not necessarily expressed in *cash*) may be definitely determined, and along *certain uniform lines.*

The question of need having been briefly (?) met, your committee will proceed to state that, as is now apparent, they have considered principally such an accounting scheme as is practicable for use by the *municipal water utilities especially,* but which is at the same time exactly the same as is prescribed for the privately owned water utilities, and followed by them.

In one or two instances the *titles* of certain controlling accounts may have been changed to suit the requirements of the municipal plants, for statements and reporting purposes, but they will be easily interpreted by the private plant officials in comparisons with their counterparts in the private works accounting statements. If private utilities should wish to adopt the scheme at any time (of course by permission of the state con-

trolling utility commissions) such minor changes in titles, etc., can easily be made by their accountants without in any way interfering with the integrity of the proposed system.

One of the members of your committee has in his office collected a number of printed pamphlets, showing the uniform classification of accounts which have been formulated and prescribed for water utilities by some of the different states in the country, together with the system formulated by the U. S. Bureau of the Census, and also current and bound copies of opinions being constantly handed down by the various public service commissions of the United States, which with much other matter has been available in this study. The various publications and authorities which have been consulted, and have furnished valuable material for appropriation in the outlined system herewith submitted, include the following:

Uniform Classification of Accounts for Water Utilities by Public Utility or Public Service Commissions (or their equivalent bodies) of the states of Maine (includes municipal water works), 1915; New Hampshire, 1915; Connecticut, 1914–1918; Pennsylvania (includes municipal water works), 1918; New Jersey (think it includes municipal works), 1913; Wisconsin (includes municipal works), 1908 (much quoted); Indiana (includes municipal works), 1913; California (think includes municipal works), 1913; Washington (State of) — (expressly for municipal works), 1916.

" Uniform Accounts for Systems of Water Supply " (for both municipal and private systems), issued by the Bureau of the Census, Washington, D. C., in 1911, and " Arranged by Representatives of the United States Bureau of the Census, American Water Works Association, New England Water Works Association, American Association of Public Accountants, Ohio Bureau of Uniform Public Accounting, and Others Interested."

Pamphlet entitled, " Interpretation of Water Works Accounts," by Mark Wolff, certified public accountant, New York City.

Paper on " Water Works Accounting," by Edwin L. Pride, certified public accountant, Boston, Mass. (referred to at the commencement of this report).

Public Utilities Reports, Annotated (containing decisions of the public service commissions and of state and federal courts) — (referred to above).

Journal of the New England Water Works Association.

Various other publications and technical journals, etc.

Also the accounting system and classification in use by the Municipal Water Works of Springfield, Mass., which was formulated and recommended by Mr. William J. Hagenah, of Chicago, public utility engineer and statistician and accountant (formerly connected with the Public Utility Commission of Wisconsin), which system was adopted by the Springfield Board of Water Commissioners and used since 1913. This system, by the way, was inaugurated and operated by the *same number* of office employees before connected with the works, and increases of em-

ployees thereafter were due to the natural growth of the business and not to the accounting system, which in fact made the accounting work much easier than in former years. This is especially mentioned as answering a possible objection in adopting any new system which may need more office help.

Besides the foregoing, the available accounting systems of certain private water works and other municipal water works were also consulted.

In the perusal and study of the various authorities referred to and listed above, your committee has appropriated whatever material and suggestions therein found and considered herein useful, without attempting to give credit mention of same in the outlined scheme submitted, but it will be understood that all due credit is hereby acknowledged by the committee without further detailed mention.

With the foregoing in mind, and supported by the weight of authority implied by the use of such available material and guides, your committee has appropriated what to them has seemed to be the best and simplest ideas and arrangements found in such authorities, and has formulated and submitted a simple but comprehensive *outline* for a possible scheme of *uniform accounting for water-works utilities*, — and especially for those owned and operated by municipalities, — shown by a set of *condensed and classified lists* of proposed accounts, *arranged in statement forms* for balance sheets and reports (instead of numerous accounts in the detail that may be called for in future), which by a little study will very readily indicate the manner and logical method of use.

In such arrangement of accounts it is assumed that the water utility should be a *self-supporting proposition* or enterprise of the municipality, and no provision is made for contribution of municipal funds towards its operation; but this provision can easily be taken care of by the utility's accountants if needed.

It is to be especially understood that your committee has not attempted to prescribe exact accounts or titles, forms of books and stationery, or any kinds of blanks or forms, and has entered into detail explanation of only a few of the indicated accounts or treatment of same. It is, however, thought that from a study of the scheme submitted any ordinary accountant can evolve and arrange for use a proper set of modern accounts for any water works utility with which he may be connected.

A very modest, but an expert, public accountant of long and practical experience in investigations of public utilities, and in formulating accounting systems for the same, a few years ago stated to one of the members of your committee that the real basis of all true accounting was " common sense " ; and in the committee's attempt to discharge properly its duties it has endeavored to keep this axiom ever in mind.

The accounting scheme submitted is outlined as follows:

A Condensed List and Statement Form for Income and Profit and Loss Accounts (for monthly and annual use) — (all accounts on Accrual — not Cash — Basis) — including Operating Revenues, Operating Expenses, Non-Operating Revenues, Deductions from Gross Income, Net Income, and Disposition of Net Income.

A Classified List of Income and Profit and Loss Accounts (*as shown on above Condensed List*) — including indicated and given explanation of these accounts, with suggested arrangement and subdivisions, all supporting condensed list.

A Condensed List of Balance Sheet Accounts (*in balance form*), *showing Assets and Liabilities in condensed balance grouping.*

A Classified List of Balance Sheet Accounts, showing Supporting Detail Accounts, with indicated or given explanations of same. *Also under Plant Accounts* is shown a possible and logical analysis of same into various physical and other units, for appraisal purposes when wanted. This analysis conforms to the different steps or processes in sequence of operation of the water utility, and corresponds to the grouping of accounts, which lends itself to the obtaining of proper data for rate and consumption questions, as well as the financial data always needed.

A Condensed Summary Form for showing Cash Receipts and Expenditures in Annual Reports, under various Funds; this is followed by a supplementary and more detailed form for use in showing funded divisions of such *cash expenditures*, where it may be wanted. Where any water utility may find it to be inexpedient to at once adopt and put into practice the suggested scheme of accounting, it may, by the use of these forms, obtain at least some uniformity for the comparison of *cash transactions* by its utility operations with the same transactions by another utility, which uniformity is also now sadly lacking. Then, whenever such utility may be in better condition to adopt the accounting system here outlined and suggested (or some other system which may be recommended by the Association), even to the extent at first of using the grouping accounts, and adding the supporting sub-accounts later, the changes will adapt themselves easily and gradually, and the cash statements can be kept as supplementary statements.

No scheme of *numbering accounts*, as is commonly used, is here submitted by your committee, as such numbering constitutes in no sense any part of the account-titles, but are used for easy reference by the accounting operators, and they may very properly be left therefore to such operators for determination as needed.

Likewise all minute definitions and instructions are here left for some possible future committee who may be appointed by your body to carry on and complete the outlined system here submitted tentatively, or to formulate and submit an entirely different system and report.

It is of course understood that the submitted scheme contemplates only the *double-entry method* of bookkeeping, and all accounting on the *accrual basis*, and not on a cash basis.

In this connection your committee desires to here record the following extract from the accounting paper before referred to, as worthy of more

absorption by all accounting operators and by water-works officials as well, viz., —

"The purposes of good accounting are to give information of the operations and reflect its financial conditions. But, in order to do this, it is necessary that the accounts show the accurate and complete record, and this can only be done by adopting the accrued basis. Recording only sums received and sums paid out, without any reference to revenue which the city would receive, or the expenditures which it would have to meet, — which would include not only amounts paid out but amounts of obligations incurred and not yet paid, — is wrong."

In closing this perhaps too-long report, your committee would wish that the membership of the Association might have an opportunity to study it in full, and be ready for later discussion of the matter at some of the winter meetings in Boston, after which some definite decision may be finally arrived at by the Association, and a modern and much-needed accounting scheme adopted and sanctioned as a standard form for use by its municipal membership, to the advantage and benefit of present and future members, and of the water-works utilities which they may represent.

With this final result in view, your committee recommends that the New England Water Works Association receive and tentatively approve this report, and order the same printed in full, for use by its members in their study and discussion at some future meetings of the Association.

Respectfully submitted,

COMMITTEE ON UNIFORM ACCOUNTING.

(Signed) Albert L. Sawyer, *Chairman.*
(Signed) Alfred R. Hathaway.
(Signed) Walter P. Schwabe.
(Signed) Samuel H. MacKenzie.
(Signed) Edwin L. Pride.

CONDENSED LIST AND STATEMENT FORM OF INCOME AND PROFIT AND LOSS ACCOUNTS.

(For Monthly and Annual Use.)

(*All Accounts on ACCRUAL — not Cash — Basis.*)

OPERATING REVENUES.

(See Classified List.)

I. — Earnings from Sales of Water to Private Consumers	$.....	
II. — Less Abatements, Refunds, etc.	.....	
		$.....
III. — Earnings from Sales of Water to the Municipality		?.....

Note: If no payment is made for municipal uses of water, state estimated total value of such uses here ($.....), — not to be included here in revenue total, — and give reasons for such non-payment. Classified accounts to be kept of such current uses and charges, and to be *charged off* at close of year *as a bad debt*, if no payment to be made.

IV. — Earnings from Use of Water by the Water Works Utility itself, and included in its Operating Charges and Expenses	.....
Total Operating Revenues (water)	$.....

OPERATING EXPENSES.

(See Classified List.)

V. — Source of Supply Expense	$.....	
VI. — Transmission Expense	.....	
VII. — Distribution Expense	.....	
VIII. — Commercial Expense	.....	
IX. — General Expense	.....	
X. — Undistributed Expense	.....	
(Show separate total of above)	$.....	
XI. — Depreciation Reserve Charge	.....	
XII. — Contingencies (extraordinary)	.....	
XIII. — Taxes	.....	
Total Operating Expenses		.....
Operating Profit		$.....
XIV. — Non-Operating Revenues (not water; net profit on mdse. sales, jobbing, rentals, etc.)		.....
Gross Income (forward)		$.....

DEDUCTIONS FROM GROSS INCOME.

XV. — Interest on Funded Debt (net)	$.....	
XVI. — Interest on Floating Debt (net)	.....	
XVII. — Interest on Other Liabilities (net)	.....	
XVIII. — Miscellaneous Deductions	.....	
Total Deductions		.....
* Net Income		$.....

* *Disposition of Net Income.* — Any payments for dividends, or appropriations for same or to Municipal Funds, should here be deducted, and *Balance of Net Income* will then be carried to Surplus Account.

Classified List of Income and Profit and Loss Accounts.

(All on Accrual — not Cash — Basis.)

OPERATING REVENUES.

Earnings from Sales of Water to Private Consumers
(See page 76 for Explanation Sheet of Classification):

	Charges.	Abatements and Refunds.	Net Revenue.
Commercial Consumers (metered)	$	$	$
Commercial Consumers (unmetered)			
Industrial Consumers (metered)			
Industrial Consumers (unmetered)			
Institutional Consumers (metered)			
Institutional Consumers (unmetered)			
Sales to Contractors (metered)			
Sales to Contractors (unmetered)			
Miscellaneous Consumers (metered)			
Miscellaneous Consumers (unmetered)			
Earnings from within city (metered)	$	$	$
Earnings from within city (unmetered)			
Total	$	$	$

(Water furnished outside city, to adjacent or suburban consumers, — including any along the line of supply or transmission mains, — should be separately classified as above and shown hereunder, divided between metered and unmetered; water furnished by contract to adjacent and suburban towns or cities — either as emergency or additional or entire supplies to same, should likewise be here shown separately and classified as "Wholesale Service," divided as between metered and unmetered, also.)

The following will serve as illustration:

Commercial Sales (.....) Transmission Main	$	$	$
Commercial Sales (.....) A, B, C Tracts			
Commercial Sales (.....) Sundry Consumers			
Industrial Sales (.....) Co. or Corporation			
Wholesale Service, Town or City of (.....)			
Earnings from outside city (metered)	$	$	$
Earnings from outside city (unmetered)			
Total	$	$	$
Total Earnings from Sales to Private Consumers:			
(Metered)	$	$	$
(Unmetered)			
Total, as per Items I and II, on Condensed Revenues Statements	$	$	$

Earnings from Sales of Water to the Municipality:

(The following alphabetical arrangement of the different departments or units is here suggested; each unit to show if metered or unmetered, or how amount is arrived at.)

	Items.	Totals.
Almshouse and Annexed Buildings	$.....	$.....
Charities Department	.....	.....
Drinking Fountains and Troughs (or Tanks)	.....	.....
Fire Department — Buildings	.....	.....
Fire Department — Municipal Hydrant Service (.....hydrants — average for year — at $..... each)	.....	.....
Forestry Department Buildings	.....	.....
Highway Department Building, Shops, Yards, etc.	.....	.....
Municipal Office Buildings (Town or City Hall, etc.)	.....	.....
Park Department Buildings	.....	.....
Park Department — Fountains, Parks, etc.	.....	.....
Police Department Buildings	.....	.....
Public Playgrounds	.....	.....
Public Sanitaries	.....	.....
School Department Buildings	.....	.....
Scavenger Department Buildings, etc.	.....	.....
Sewer Department Buildings	.....	.....
Sewer Department — Flushing Purposes, etc. (state how amounts are arrived at)	.....	.....
Street Sprinkling and Washing (state how amount is arrived at)	.....	.....

(Besides subdivisions of "metered" and "unmetered" amounts, the foregoing departmental units are subject to further subdivisions and additions, as may be desirable in different towns or cities.)

Total Earnings from Sales to the Municipality, as per Item III on Condensed Revenues Statement:		
(Metered)	$.....	
(Unmetered)	.....	$.....*

Earnings from Water Used by the Water Works Utility and Included in its Operating Expenses:

(Show where used and amounts metered and unmetered)	$.....	
	.....	
Total, as per Item IV on Condensed Revenues Statement		$.....

* If no cash payment is made by the municipality for this amount, state the fact here, as well as on Condensed Statement.

OPERATING EXPENSES.

	Operation.	Maintenance.	Totals.
Source of Supply Expense:			
(Showing following divisions) —	$.....	$.....	$.....
Superintendence.			
Pumping System expense (if not gravity) (subdivided as to kind of power).			
Collecting System expense.			
Purification System expense.	(All items and totals		
Water Storage System expense.			
Supply Sanitation System expense.	to be distributed to		
(Each above division subdivided to show following) —	above heads and columns.)		
Operating Labor.			
Supplies and Expenses (detail accounts).			
Maintenance (repairs and upkeep) of buildings, fixtures, grounds, structures, equipment, etc. (detail accounts).			
	$.....	$.....	

Total Source of Supply Expense, as per Item V on Condensed List . . $.....

	Operation.	Maintenance.	Totals.
Transmission Expense:			
(Showing following divisions) —	$.....	$.....	$.....
Superintendence.			
Buildings, Fixtures and Grounds expense.			
Structures and Equipment expense.			
Transmission Telephone Lines expense.	(All items and totals		
Patrolling Transmission Mains expense.			
(Each of above divisions subdivided to show following) —	to be distributed to		
Operating Labor.	above heads and columns.)		
Supplies and Expenses (detail accounts).			
Maintenance (repairs and upkeep) of buildings, fixtures, grounds, structures, and equipment, etc. (detail accounts).			
	$.....	$.....	

Total Transmission Expense, as per Item VI on Condensed List . . . $.....

	Operation.	Maintenance.	Totals.
Distribution Expense:			
(Showing following divisions) —	$	$	$
Superintendence.			
Street Division expense.			
Meters and Fittings Division expense.			
Consumers' Premises expense.			
Dist'n Buildings, Fixtures and Grounds expense.	(All items and totals		
Distribution Structures and Equipment expense.			
Miscellaneous Distribution expense.	to be distributed to		
(Each above division to be subdivided to show following) —	above heads and columns.)		
Operating Labor.			
Supplies and Expenses (detail accounts).			
Maintenance (repairs and upkeep) of buildings, fixtures, structures, equipment, distribution mains, hydrants, gates and valves, services, meters, fountains and troughs, etc.			
	$	$	
Total Distribution Expense, as per Item VII on Condensed List			$

Commercial Expense:	
Commercial Division Salaries	$
Commercial Division Supplies and Expenses	
Reading Meters Salaries	
Reading Meters Supplies and Expenses	
Miscellaneous Commercial Expenses	
Undistributable Inspection Expenses	
Total Commercial Expense, as per Item VIII on Condensed List	$

	Operation.	Maintenance.	Totals.
General Expense:			
Salaries of Officers and Assistants.	$	$	$
Salaries of General Office Clerks.	(All items and totals		
General Office Supplies and Expenses.			
General Law and Legislative Expenses.	to be distributed as		
Maintenance of General Office Structures.			
Maintenance of General Office Equipment.	described above.)		
	$	$	
Total General Expense, as per Item IX on Condensed List			$

Undistributed Expenses:	
Injuries and Damages	$
Utility Equipment Expense, Automobiles	
Utility Equipment Expense, Teams	
Insurance Expense	
Stock and Stores Expense	
Shop Expense	
Pensions and Relief Expense	
Suburban Supplies Expense	
Miscellaneous Expense	
Inventory Adjustments (debit or credit)	
Total Undistributed Expense, as per Item X on Condensed List	$

Depreciation Reserve Charge:

This operating account (as well as the " Depreciation Reserve " account under Liabilities) is prescribed by all public-utility commissions and accounting authorities of the present day; is insisted upon for all privately owned utilities by controlling commissions (and for municipally owned utilities by such commissions in certain states); and should be carried by all municipally owned utilities as a needed element in proper accounting.

This account should be *charged periodically* (monthly suggested) a proportional amount of the estimated annual depreciation of the capital tangible property in service of the utility, which annual depreciation shall be estimated to cover the cost of future replacements of tangible property, made and to be made necessary on account of gradual wear and tear and obsolescence and inadequacy during the life of such property. It is recommended that, in determining such depreciation, an annual schedule be maintained, showing the various physical units of tangible property in accordance with the classified list of same under " Assets " (herewith accompanying), and with estimated depreciation of each unit shown on the percentage basis.

The effect of thus carrying proportional charges into annual " Operating Expenses " is the distribution of the burden of such certain costs throughout the years of service of such property.

The cost of hand and other small portable tools is not chargeable to this account, but are included in and charged to the operating expenses of the year in which they are purchased.

All amounts *charged* to this account shall be *credited* at the same time to the " Depreciation Reserve " account, under Liabilities, as therein described; and the cost of all unit renewals and replacements shall be charged to the latter account and not to this account.

Total Depreciation Reserve Charge, as per Item XI on Condensed List $.....

Contingencies (Extraordinary):

When the property of the utility is visited by an extraordinary casualty of such a nature as to be beyond anticipation through the exercise of ordinary and reasonable prudence, and of such a nature as not to be contained in the provisions for depreciation (as earthquakes, floods, cyclones, etc.), resulting in irreparable damage, there may be charged to this account the original cash cost of such irreparable damaged property, less the salvage or scrap value and irreparable wear and tear from use accrued thereto. When the amount of such damage or loss is considerable, there may be set up an *Extraordinary Casualties Suspense Account*, to which may be credited monthly the amount charged to the account *Contingencies (Extraordinary)* until the total loss or damage caused by such casualty shall be wiped out through operating expenses.

Total Contingencies (Extraordinary), as per Item XII on Condensed List . . . . . $.....

Taxes:

Charge to this account the amount paid or accrued for taxes of every description, including taxes on poles, real estate, buildings, capital stock or equity, franchises, gross receipts, easements, and federal taxes.

Total Taxes, as per Item XIII on Condensed List . . . . . $.....

NON-OPERATING REVENUES.

Net profit on sales of products (wood, sand, hay, etc.), merchandise sales, jobbing, and other work, rentals of land, buildings, etc., — classified separately for ready reference.

Total Non-Operating Revenues, as per Item XIV on Condensed List . $.....

DEDUCTIONS FROM GROSS INCOME.

Classify separately net amounts of interest for each class and issue of bonds and other obligations, and also amounts of other deductions, as indicated in condensed list.

Total Deductions from Gross Income, as per Items XV, XVI, XVII, XVIII, on Condensed List . . . . . $.....

CONDENSED BALANCE SHEET ACCOUNTS. FOR SELF-SUPPORTING WATER-WORKS UTILITY.

(*All Accounts on Accrual — not Cash — Basis.*)

ASSETS.*

XIX. — Plant, Property and Equipment (Cost Basis), ...192.....
(aggregate at date of new accounting) . . . . . $.....
XX. — Additions to Plant, Property and Equipment (Cost Basis) since.....192.... (since new accounting) . . . .

(Showing total cost to date) . . . . . $.....
XXI. — Stock and Stores . . . .
XXII. — Accounts Receivable . . . .
XXIII. — Cash (General Current Funds) . . . .
XXIV. — Cash (Special Funds) . . . .
XXV. — Sinking Funds . . . .
XXVI. — Miscellaneous Current Assets . . . .

Total Assets . . . . . $.....

LIABILITIES.*

XXVII. — City (or Town) of.....Equity (Capital Investment Account) . . . . . $.....
XXVIII. — Funded Debt (Bonded Obligations) . . . .
XXIX. — Mortgage Liabilities . . . .
XXX. — Current Liabilities . . . .
XXXI. — Accrued Liabilities . . . .
XXXII. — Depreciation Reserve . . . .
XXXIII. — Other Reserves . . . .
XXXIV. — Surplus (Unappropriated) . . . .

Total Liabilities . . . . . $.....

CLASSIFIED LISTS OF BALANCE SHEET ACCOUNTS. SHOWING SUPPORTING DETAIL ACCOUNTS AS SUGGESTED THEREUNDER.

(*For Current Annual Use.*)

ASSETS.

XIX.— *Plant, Property and Equipment* (*Cost Basis*),.....*192*.... (*as per Condensed List*).

(Aggregate of all property acquired or installed prior to adoption of new accounting system, and to be shown as separate total until such time as an appraisal and physical classification may be made of same, for *merging* with subsequent additions which may have been properly classified under the new accounting system.)

XX. — *Additions to Plant, Property and Equipment* (*Cost Basis*) *since*.....*192*.... (*as per Condensed List*).

(Aggregate of all property acquired or installed subsequent to adoption of new accounting system, and to be annually shown as a separate cumulative total until such time as a merged appraisal and physical classification of the entire plant and property may be made.)

The following is a suggested *Classifications of Plant and Property Accounts*, as logically needed in both the appraisal and the operation until such appraisal may be

* See *Classified Lists* of Assets and Liabilities Accounts, following.

made. Such classification can be immediately used upon adoption of the accounting system, for all operations thereafter.

Intangible Property.

Should include:

1. — Organization Costs.
2. — Franchises, Rights, and Licenses.
3. — Other Intangible Property.

Tangible Property.

Should include:

1. — *Lands Used in Operation (subdivided as follows):*
   - *a* — Pumping Station Land.
   - *b* — Source of Supply and Collecting System Land.
   - *c* — Purification System Land.
   - *d* — Water Storage Land.
   - *e* — Supply Transmission Land.
   - *f* — Distribution System Land.
   - *g* — Stores Department Land.
   - *h* — Utility Equipment Land.
   - *i* — General Office Land.
   - *j* — Other Lands Devoted to Operation.
2. — *Buildings, Fixtures, and Grounds (subdivided as follows):*
   - *a* — Pumping Station, Buildings Fixtures, and Grounds.
     (Separate accounts for Steam Power, Hydraulic Power, Electric Power, Gas Power, etc.)
   - *b* — Source of Supply and Collecting System B., F., and G.
   - *c* — Purification System B., F., and G.
   - *d* — Water Storage B., F., and G.
   - *e* — Supply Transmission B., F., and G.
   - *f* — Distribution System B., F., and G.
   - *g* — Stores Department B., F., and G.
   - *h* — Utility Equipment B., F., and G.
   - *i* — General Office Equipment B., F., and G.
   - *j* — Other B., F., and G. devoted to Operation.
3. — *Structures and Equipment Used in Operation (subdivided as follows):*
   - *a* — Pumping Stations Equipment.
     (Separate accounts for Steam Power, Hydraulic Power, Electric Power, Gas Power, etc.)
   - *b* — Source of Supply and Collecting System Structures and Equipment.
     (Separate accounts for Collecting Aqueducts, Dams, Intakes, Supply Mains, etc.)
   - *c* — Purification System Structures and Equipment.
   - *d* — Water Storage Structures and Equipment.
   - *e* — Supply Transmission Mains.
   - *f* — Supply Transmission Telephone Lines and Equipment.
   - *g* — Distribution System Structures and Equipment.
     (Separate accounts for Distribution Mains, Hydrants, Services, Meters, Fire Cisterns, Basins, Fountains and Troughs, Distribution Telephone Lines and Equipment, etc.)
   - *h* — Stores Department Equipment.
   - *i* — Utility Equipment.
   - *j* — General Shop Equipment and Tools.
   - *k* — General Office Equipment.
   - *l* — Miscellaneous Equipment.

4. — Miscellaneous Construction and Equipment Expenditures (during construction and before operation):

a — Engineering and Superintendence.
b — Salaries.
c — Office Supplies and Expenses.
d — Stationery and Printing.
e — Law Expenses.
f — Injuries and Damages.
g — Insurance.
h — Taxes.
i — Interest.
j — Discount on Bonds.
k — Miscellaneous Construction Expenses (not includable above).
l — Unfinished Plant Investment (current account only).
m— Property in Other Departments (devoted to other than water operations).
n — Cost of Plant Purchased (in lieu of construction).

5. — Investments.

To include properties acquired not for use in present operations, but for proper control over other property in the utility service, or for devotion to future operations.

Appropriate subdivisions of this account should be made to keep separate the different classes or units of such investments.

XXI. — *Stock and Stores (per annual inventories and current changes):**

Main Pipe Stock (including fittings, hydrants, gates, etc.)		$.....
Service Pipe Stock (including fittings and appurtenances)		.....
Meter Stock (including fittings and appurtenances)		.....
Small Tools Stock (hand tools, etc.)		.....
Miscellaneous Stores and Supplies (not includable elsewhere)		.....
Engineering Supplies		.....
General Office Supplies		.....
		$.....
Collecting System Supplies	$.....	
Pumping System Supplies	.....	
Purification System Supplies	.....	
	.....	.....
* Total Stock and Stores		$.....

XXII. — *Accounts Receivable.*

To include all amounts on open accounts due the water works utility from consumers and other parties.

XXIII — XXIV. — *Cash Accounts.*

General revenue funds should be kept entirely separate from any special funds, and the latter may be subdivided into as many accounts as may be deemed desirable.

XXV. — *Sinking Funds.*

To include all funds set apart or deposited with trustees, for the purpose of redemption of outstanding bonds and similar debt obligations, together with all income derived from such funds. Should be subdivided into separate accounts for each separate sinking fund.

* Inventories should be taken periodically, at least as often as once a year, and differences investigated and cleared. Above subdivisions are optional and changeable, but will greatly assist in locating shortages and overages disclosed by inventories and to be disposed of through proper adjustment accounts.

XXVI. — *Miscellaneous Current Assets.*

To include cost of current assets not includable under any of those already defined.

LIABILITIES.

XXVII. — *City (or Town) of.....Equity.*

For municipally owned water-works utilities this account is especially recommended in place of *Capital Account*, or *Capital Stock Account*, and as better representing by title the owners' growing equity or paid-up interest in the utility investment. This account should be set up as of date when new accounting system may be adopted, to include all accruals of this nature to such date. And thereafter all costs for construction or property paid for from earnings, and amount of all construction bonds or other similar debt obligations retired or canceled by payments from earnings or from funds derived from earnings, should be credited or transferred to this account from the surplus account.

XXVIII. — *Funded Debt (bonded obligations).*

A separate account should be set up and kept for each different issue and class of bond obligation.

XXIX. — *Mortgage Obligations.*

To include all mortgage liabilities or obligations except such as are evidenced by bonds. Separate accounts should be set up and kept for the different classes of such obligations.

XXX. — *Current Liabilities.*

To include the following accounts, viz., Accounts Payable, Consumers' Deposits, Matured Interest Unpaid, Miscellaneous Current Obligations.

XXXI. — *Accrued Liabilities.*

To include the following accounts, viz., Unmatured Interest Account, Unmatured Insurance Account, Unmatured Taxes Account, Miscellaneous Liabilities Accrued.

XXXII. — *Depreciation Reserve.*

To this account shall be *credited* monthly — or as often as they are made — all charges to *Operating Expenses* under "Depreciation Reserve Charge" account, as thereunder described; together with any income derived from the depreciation reserve fund (if such *fund* is established), and any appropriations which may be made to it.

When any building, structure, transmission, or distribution main, facility or unit of equipment, originally charged to capital assets and included in tangible property, becomes through wear and tear in service economically irreparable, the substitute therefor (having substantially no greater capacity than the unit for which it is substituted) shall be *charged* to this account.*

The salvage or scrap value of any unit of equipment retired from service or replaced by another unit should be *credited* to this account.

XXXIII. — *Other Reserves.*

For any other reserves, including any temporary or optional reserves, not elsewhere provided for.

XXXIV. — *Surplus Account (balance unappropriated).*

This account will include all collective amounts of *annual net income balances*, less amounts transferred to the "City of.....Equity Account," as thereunder described.

At the close of each fiscal yearly period the surplus balance will represent the amount by which the assets exceed the liabilities.

Note. Should the annual operation of the water-works utility result in a *continued net loss*, then the cumulative totals of such net losses would appear as a *deficit account* on the debit side of the balance sheet, under Assets, and would represent the amount by which the liabilities exceeded the assets.

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* For the purpose of segregation and future ready reference, it is recommended that the cost of all renewals and replacements of capital property be first charged to a current "*Renewals Account*," which will then be annually closed into the Depreciation Reserve account as one total annual amount.

CONDENSED SUMMARY OF CASH RECEIPTS AND EXPENDITURES, DURING 192.....
(For Annual Reports.)

Items.*	Water-Works Revenues.	Bond and Loan Funds.	Special Funds.	Totals.
Receipts — 192.....				
Collections of Revenues, —				
Water Sales (operating)	$.....			
Misc. Sales (non-operating)	.....	....	....	$.....
Unclaimed Wages (years of.....)	.....	....	....	.....
Refunds (sundry accounts)	.....	....	....	.....
Proceeds from Bond Sales and Loans	....	$.....	....	.....
Other Receipts (miscellaneous)	?.....	....	?.....	.....
Total Receipts, Current Year	$.....	$.....	$.....	$.....
Transfers (+ or —) (if any)	?	?	?	
Balances Forward from Prior Year	?	?	?	?.....
Total Receipts and Balances, 192.....	$.....	$.....	$.....	$.....
Expenditures — 192.....				
Bills Approved and Paid	$.....	$.....	$.....	$.....
Pay-rolls Approved and Paid	.....	.....	.....	
Interest Paid on Bonds	.....	.....	.....	.....
Interest Paid on Loans	.....	.....	.....	
Bonds Due and Paid	.....	.....	.....	.....
Loans Due and Repaid	.....	.....	.....	
Bond Sinking Funds	.....	.....	.....	.....
Appropriations and Reserves	.....	.....	.....	.....
Total Expenditures, Current Year	$.....	$.....	$.....	$.....
Balances Forward to Next Year	?	?	?	?.....
Total Expenditures and Balances, 192.	$.....	$.....	$.....	$.....

* See *Division* of Cash *Expenditures*, following.

DIVISION OF CASH EXPENDITURES — 192.....

(For Annual Reports.)

FROM WATER-WORKS REVENUES.

Operating Expenses (not including Depreciation Reserve Charges):

Total, as per Income and Profit and Loss Account . . . . . $.....
Less amounts included, not Cash . . . .
$.....

Construction (Additions to Plant and Property):

Intangible Property . . . . . } Cost charges, — less amounts
Lands and Easements . . . . . } not cash, — under groups here
Buildings, Fixtures, and Grounds . . . . . } shown, and by items as per
Structures and Equipment . . . . . } classified lists elsewhere given.
Miscellaneous Construction Equipment . . . . } .....
....

Renewals and Replacements (of Plant and Property):

Including Buildings, Fixtures and Grounds, Structures and Equipment; Transmission Mains, Distribution Mains, Hydrants, Gates, Services, Meters in Service, Utility Equipment; and all other tangible property used in operation, subject to depreciation. (The total costs of such expenditures are those chargeable to Depreciation Reserve Account, and includable in estimated amount of "Depreciation Reserve Charge" as debited to current Operating Expenses, and as shown elsewhere). } Cost charges, — less amounts not cash, — under groups and accounts by items as per classified lists given elsewhere.
.....
....

Cost of Miscellaneous Sales, — Non-Operating Revenue Accounts:

Costs of Labor and Material charged consumers, Jobbing, Rentals, etc. (net) . . . .
Stock and Stores Increase or Decrease during Current Year:
Plus or minus cost difference shown in such account . . . .
Miscellaneous and Cost Adjustment Accounts (net) . . . .
.....

Total Approved Bills and Pay-rolls Paid (from revenue), (as per Cash Summary Statement) . . . . . $.....

Interest Payments (net total) . . . . . $.....
Bond and Loan Payments (net total) . . . .
Sinking Fund Payments (net total) . . . .
.....

Total Debt Requirements . . . .
.....

Total Cash Expenditures (as per condensed cash summary) . . . . . $.....
Appropriations and Reserves (cash transfers) . . . .
.....

Total Cash Payments from 192..... Revenues (per cash summary) . . . $.....

(In similar manner itemize cash expenditures from Bond and Loan Funds and from Special Funds, to agree with such totals in cash summary statement.)

Explanation Sheet of Classification of Earnings from Sales of Water to Private Consumers.

(Public Uses — by Municipalities — indicated on page 65.)

The following divisions and accounts (not shown elsewhere in the classified lists of accounts) are suggested for purposes of ready reference and comparisons by one water-works utility with another, and are in agreement with those adopted and recommended by the N. E. W. W. A. for use in its "Summary of Statistics" for annual reports. They will also be found useful for other statistical purposes in connection with studies of rates and consumption questions, etc.

	Code.*
Domestic. — To include only residences, dwellings, tenements, apartment blocks, flats, etc.; also hotels and boarding-houses where there are no predominant strictly commercial uses.	D
Domestic and Commercial. — To include (as one combination class) *only* premises where stores, offices, shops, or any business uses, or commercial uses (not industrial), are located in *same building* with residences, tenements, apartments, hotels, etc., and all supplied or billed as one and the same service.	DC
Commercial. — To include stores, office buildings, saloons, retail commercial establishments, theaters, etc.; also where *some* manufacturing or industrial uses are found in combination with such commercial, *if the commercial service is the principal and predominating one.*	C
Churches. — To include all uses by churches and affiliated buildings, etc.	CH

The following are the commonly suggested divisions for *Accounting* purposes, as prescribed by different Public Utility Commissions, etc., and as shown elsewhere in the suggested classified lists of accounts.

Commercial. — To include the *foregoing four divisions,* as described above.	C
Industrial. — To include only premises used *exclusively* for manufacturing or industrial purposes; such as railroads, breweries, bottling works, laundries, factories, warehouses, foundries, gas works, etc.; also where *some* commercial service is found in combination with the industrial, *if the industrial service is the principal and predominating one.*	I
Institutional. — To include such premises and uses as city libraries, art museums, science buildings, courthouses, registry buildings, government buildings, jails, truancy and reform buildings, hospitals, cemeteries, nurseries, private schools and academies, colleges and universities, armories, Y. M. C. A. and Y. W. C. A. buildings, etc.	INST
(This is a distinct division recently adopted by one of our leading authorities in prescribing a new accounting system for a New England city, and is worthy of general use.)	
Builders' Use. — To include all uses by builders and contractors.	BU
Unclassified. — To include all *miscellaneous uses* not classified above, such as for circuses and other temporary uses.	MISC

* The code letters shown above will be found useful in embossing on addressing plates and printing on bills, and for reference use on any statements and classification sheets in current work. Special code letters can be adopted for uses supplied outside of city, with account numbers for same.

ANNUAL MEETING.

Address of Mr. Henry V. Macksey, President N. E. W. W. Association, 1920.

Gentlemen of the New England Water Works Association, — To-day the present officers complete the work of the year and turn over to their successors the duties and responsibilities which you have placed upon them.

The work of the past year has been uneventful. The meetings have been well attended, the papers presented of value fully equal to that of preceding years, and the convention was very successful, the attendance being all that could be expected and the interest shown by the members in taking part in discussion of papers presented being greater than usual.

The entertainment provided by the people of Holyoke and by the Manufacturers' Association was more attractive even than that at previous conventions.

The Association is in a sound condition financially, even though we were forced to draw upon our reserve fund to pay for the roster of the Engineer Regiment, which we felt was money well expended, and to pay for an issue of the 1919 Journal which was overdue when the present administration took charge.

The cost of living has increased for the Association as well as for its members, and in order to meet it an increase in dues became necessary. Your officers felt that, no matter what the Journal cost, no valuable material should be refused publication, and in spite of the tremendous increase in cost of paper and printing it is of as good quality as heretofore.

To avoid increased cost to the members personally, the meeting and dining place has been changed. Your dinners are as satisfactory as before, but, unfortunately, the dining room is not as well adapted for the display of pictures upon the screen as the room we have occupied in the past. It is possible that in the near future we may be able to make some better arrangement without making the cost prohibitive.

We have lost a few members through death, and quite a few through resignation and being dropped on account of dues. The Secretary will give you the details, so that I will merely say that our net loss is 20 active and 7 associate members, and that makes it evident that we must soon start a very active campaign to increase the number of members in both classes.

The retiring officers desire to thank the members for their loyal support through the past year. [*Applause.*]

Address of Charles W. Sherman,
President-Elect, 1921.

Mr. President and Friends,— I have not prepared any set speech — I do not believe you care particularly to listen to one, anyway — and if you did I have no specific program or budget or anything else for the year to announce, different from that of the earlier years.

I am one of those who believe very earnestly in this Association, its place and its work, and having that belief I esteem the presidency of it as a high honor, and appreciate it accordingly. I know that the associates you have given me on the Executive Committee will work earnestly to keep up the good record which our predecessors have maintained, and with the assistance of the " steering committee," as perhaps I may call it, which you have just authorized, I hope that we may be able to present for your attention a better coördinated, if not more valuable, program of papers than it has previously been possible to obtain. Certainly the existence of such a committee offers great possibilities in so coördinating and laying out the program for the year.

One point which is brought forcibly to my attention by the failure to receive any committee reports to-day, in spite of the long list printed in the notice of the meeting, suggests a little more careful consideration of the working of committees than perhaps has been the case in the last few years. Up to a year ago there was every excuse for the practical abandonment of committee work during the progress of the war, and it became the practice during that time almost to forget that there were committees, — certainly to forget to expect reports from them, and perhaps that experience had continued to govern the committees somewhat in their recent action — or inaction, perhaps I might better say. I am a member of one or two of those committees myself, so that I feel no particular hesitation in using such terms. Nevertheless, the record of the Association in the past has been attained in large measure from the excellence of its committee work, and we cannot afford to let it fall down. The committees must be revived, if they are worth reviving, and, if not, discontinued.

Some of the committees, I know, have programs which involve work that can't well be rounded up in a single year, or sometimes in three or four years. They involve a campaign of education or its equivalent which requires a long period for its ultimate conclusion, and I believe it would be unfortunate to provide, as is done in many societies, that all committees shall expire at the annual meeting unless reappointed. Of course we could reappoint them, but I believe it more advantageous as a general practice that the membership should be continued without the formality of reappointment if the committee is worth while and, as a whole, doing good work. But I do not think it is wise to let them drift along, as perhaps has been the case with some of them.

Another thing that is forcibly brought to our attention particularly by the loss in membership is, not only that we need new members but that we need more young members. I have been holding office, off and, on in this Association for the last twenty-two years; I was a good deal younger man when I started in doing that than I am now. It seems to me as though a very much larger number of my contemporaries at the time I started are now holding office than those who are of the age that I was at that time, and I believe that it would be decidedly to the advantage of the Association if we had more young blood in the membership and taking a more active part in the work. I hope that the members, as far as they can, will get new membership and will urge the younger men to have a more active interest in the work of the Association.

I know that in many cases some of our younger members feel that their time is not available for attendance at afternoon meetings. To a certain extent that feeling may be warranted, although I think in a good many cases if the younger members would call the attention of their superiors to the conditions they would have little difficulty in obtaining permission to absent themselves for these meetings. Certainly I believe that an employer usually receives more than the value of the lost time by permitting his assistants to attend such meetings as ours.

Again I thank you for the election. [*Applause.*]

Report of Secretary.

JANUARY 3, 1921.

Mr. President and Gentlemen of the New England Water Works Association, — The Secretary submits herewith the following report of the changes in membership during the past year, and the general condition of the Association.

The present membership is 872, constituted as follows: 14 Honorary, 788 Active, and 70 Associate Members, there being a net loss for the year of 27. The detailed changes are as follows:

MEMBERSHIP.

January 1, 1920.	Honorary Members	12			
	Transferred from Members	2			
		—			14
January 1, 1920.	Total Members			810	
	Withdrawals:				
	Resigned	39			
	Dropped	20			
	Died	6			
		—	65		
	Transferred to Honorary Members		2		
			—	67	
				—	743

	Initiations:				
	January	3			
	February	3			
	March	5			
	September	23			
	November	6			
	December	2			
		—		42	
	Reinstated:				
	Member dropped in 1914	1			
	Elected in 1919, qualified 1920	2			
		—		3	
				—	788
January 1, 1920.	Total Associates		77		
	Withdrawals:				
	Resigned	7			
	Dropped	2			
		—	9		
			—	68	
	Initiations:				
	September	2		2	
		—		—	70
January 1, 1921.	Total membership				872
January 1, 1920.	Total membership				899
	Net loss				27

Receipts for 1920.

Initiation fees			$214.00
Annual dues:			
Members	$3 192.61		
Associates	1 365.00		
		$4 557.61	
Fractional dues:			
Members	$39.00		
Associates	10.00		
		49.00	
Past dues		4.00	
Total dues			4 610.61
Advertising			3 198.76
Subscriptions			313.00
JOURNALS sold			2 394.05
Sundries			614.06
Total receipts			$11 344.48

There is due the Association:

Advertisements	$90.25
JOURNAL	1.00
Reprints	43.94
Standard Specifications for C. I. Pipe	25.00
Total	$160.19

Respectfully submitted,

FRANK J. GIFFORD, *Secretary.*

REPORT OF TREASURER.

CLASSIFICATION OF RECEIPTS AND EXPENDITURES.

Receipts.

Dividends and interest		$288.96
Initiation fees	$214.00	
Dues	4 610.61	
Total received from members		4 824.61
JOURNAL:		
Advertisements	$3 198.76	
Subscriptions	313.00	
JOURNALS	2 394.05	
Sale of reprints	68.25	
Total received from JOURNAL		5 974.06
Miscellaneous:		
Sale of " Pipe Specifications "	$6.00	
Dinners	411.00	
Certificates of membership	13.50	
Button	1.00	
Meter rate sheets	5.10	
June excursion	45.35	
Membership lists	11.00	
Willard Kent testimonial	38.93	
Index	1.00	
Total miscellaneous receipts		532.88
Total receipts		$11 620.51

Expenditures.

JOURNAL:		
Advertising agent's commission	$251.95	
Printing	9 125.09	
Editor's salary	300.00	
Editor's expense	47.79	
Reporting	296.22	
Reprints	592.25	
Envelopes and postage	83.43	
Advertising refund	14.00	
		$10 710.73
Office:		
Secretary's salary	$200.00	
Assistant Secretary's salary	1 080.00	
Assistant Secretary's expense	124.55	
Rent	600.00	
Printing, stationery, postage	322.22	
Telephone	15.56	
Miscellaneous	13.75	
		2 356.08
Meetings and Committees:		
Stereopticon	$10.00	
Dinners	423.60	
Music	5.00	
Printing, stationery, and postage	245.80	
Badges	65.00	
Traveling expenses	150.49	
		899.89
Miscellaneous:		
Treasurer's salary and bond	$67.50	
Certificates of membership	4.30	
Dues refunded	4.00	
Standard Specifications	43.95	
W. Kent testimonial	20.33	
Income tax	7.59	
Miscellaneous	6.50	
		154.17
		$14 120.87

REPORT OF AUDITING COMMITTEE.

We have examined the accounts of the Secretary and Treasurer of the New England Water Works Association, and find the books correctly kept and the various expenditures of the past year supported by duly approved vouchers. The Treasurer has also accounted to us for the investments and cash on hand, as submitted in the above report.

GEORGE H. FINNERAN,
GEO. A. CARPENTER,
FRANK A. MARSTON,
Finance Committee.

LEWIS M. BANCROFT, *Treasurer*,
In account with the New England Water Works Association.

RECEIPTS.			EXPENDITURES.		
1920.					
Jan. 1. Balance on hand		$3 945.53	Bills paid		$14 120.87
Received of F. J. Gifford, Secretary		11 344.48			
Interest on bonds and deposits		266.03	BALANCE ON HAND.		
			People's Savings Bank	$1 000.00	
			Mechanics Savings Bank	183.54	
			First National Savings Bank	186.85	
			Liberty Trust Co.	64.78	1 435.17
		$15 556.04			$15 556.04

ASSETS AND LIABILITIES.

ASSETS.			LIABILITIES.	
Cash balance in banks		$1 535.17	Surplus	$3 510.36
Bonds Nos. 2642 and 2644 Lake Shore & Michigan Southern R. R. 4s, due 5–1–1931.		1 815.00		
Accounts receivable:				
Advertising	$90.25			
JOURNAL	1.00			
Reprints	43.94			
Pipe specifications	25.00	160.19		
		$3 510.36		$3 510.36

BOSTON, January 10, 1921.

LEWIS M. BANCROFT, *Treasurer*.

Report of Editor.

January 18, 1921.

The Editor submits the following report for 1920, covering Volume XXXIV of the Journal.

The report does not give the receipts and expenditures of the calendar year, which have been stated in the report of the Treasurer, but aims to furnish the total cost and receipts of Volume XXXIV.

The accompanying tabulated statements show, in detail, amount of material in the Journal.

Size of Volume. — The volume contains 520 pages, a decrease of 206 pages from that of 1919.

Reprints. — Twenty-five reprints of papers have been furnished to each author without charge.

Circulation. — The present circulation of the Journal is:

Members, all grades	872
Subscribers	84
Exchange	14
Total	970

a decrease of 32 from the preceding year. Journals have been sent to all advertisers.

Advertisements. — There has been an average of 31 pages of paid advertisements, with an income of $2 759.35, an increase over last year of $895.60. The gain is largely due to increase in rates for advertising.

Pipe Specifications. — During the year the specifications for cast-iron pipe to the value of $25.00 have been sold. The net gain up to a year ago had been $297.10, so that the total net gain from this source to date is $322.10, and 149 copies of specifications on hand worth $37.25 if sold at retail.

The Association has a credit of 28c. at the Boston Post-Office, being the balance of money deposited for payment of postage upon Journal at pound rates. The following tables are for Volume XXXIV, not for the calendar year. The *receipts* and *expenditures* show total charges and accounts payable, with no reference to amounts actually received or disbursed.

TABLE 1.

Statement of Material in Volume XXXIV, Journal of the New England Water Works Association, 1920.

Date.	Pages of								
	Papers.	Proceedings.	Total Text.	Index.	Advertisement.	Cover and Contents.	Insert Plates.	Total.	Total Cuts.
March	66	24	90	0	33	4	2	129	33
June	45	3	48	0	35	4	...	87	5
September	78	21	99	0	36	4	...	139	7
December	114	8	122	3	36	4	...	165	11
Total	303	56	359	3	140	16	2	520	56

TABLE 2.

RECEIPTS AND EXPENDITURES ON ACCOUNT OF VOLUME XXXIII, JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION, 1920.

Receipts.		*Expenditures.*	
Advertisements	$2 759.35	Printing JOURNAL and mailing	$3 352.58
Sale of JOURNALS	98.25	Printing and preparing illustrations	345.02
Sale of reprints	112.19	Editor's salary	300.00
Subscriptions	313.00	Editor's incidentals	11.96
JOURNAL Index	1.00	Advertising agent's salary and commission	188.00
Meter rate specifications	5.10	Reporting	296.22
	$3 288.89	Reprinting	517.25
Net cost of JOURNAL	1 722.14		
	$5 011.03		$5 011.03

During the past year we have published the history of the 26th Engineers Regiment, the water-supply regiment of the American Expeditionary Forces in France. This history was made a second section of the December, 1919, JOURNAL and was sent to the members of the Association under the regular cover of the JOURNAL, and without the general roster; 1 650 copies in a special cover were furnished the regiment.

Appreciation is due the advertisers who cordially accepted the double 1919 rates which were made for this issue, and assisted the Association substantially in carrying out this patriotic project.

The following is financial statement of publishing history:

Cost.		
Printer's bill for printing and mailing		$4 137.58
Extra postage		24.08
Commissions on advertisements		88.75
Editor's expense		1.00
		$4 251.41
Income.		
Cash from fund subscribed to regiment	$2 296.80	
Advertising	707.50	3 004.30
		$1 247.11
* Credit for yearly index		45.05
Total net cost to the Association of 26th Engineers Regiment history		$1 202.06

Respectfully submitted,

HENRY A. SYMONDS, *Editor.*

* The cost of index should properly be added to the reported cost of Vol. XXXIII.

TABLE 3.

COMPARISON BETWEEN VOLUMES XXIV TO XXXIV, INCLUSIVE (OMITTING VOLUME XXXI), NEW ENGLAND WATER WORKS ASSOCIATION.

	Vol. XXIV. 1910.	Vol. XXV. 1911.	Vol. XXVI. 1912.	Vol. XXVII. 1913.	Vol. XXVIII. 1914.	Vol. XXIX. 1915.	Vol. XXX. 1916.	Vol. XXXII. 1918.	Vol. XXXIII. 1919.	Vol. XXXIV. 1920.
Average edition (copies printed)	1 150	1 000	1 000	1 000	1 050	1 325	1 500	1 388	1 200	1 150
Average membership	732	752	740	745	803	904	1 002	954	902	885
Circulation at end of year	827	840	826	858	951	1 079	1 155	1 010	1 002	970
Pages of text	643	475	401	554	564	596	538	398	566	359
Pages of text per 1 000 members	880	632	542	746	702	659	538	417	627	406
Total pages, all kinds	808	654	567	733	719	776	707	557	726	520
Total pages per 1 000 members	1 090	870	766	984	895	859	707	584	805	588
GROSS COST:										
Total	$3 490.81	$2 625.87	$2 476.55	$3 586.29	$3 345.87	$4 243.35	$3 386.63	$3 115.00	$4 967.99	$5 011.03
Per page	4.32	4.02	4.37	4.89	4.65	5.47	4.79	5.59	6.84	9.64
Per member	4.78	3.50	3.35	4.81	4.17	4.68	3.38	3.26	5.51	5.66
Per member per 1 000 pages	5.90	4.09	5.90	6.46	5.80	6.02	4.79	5.85	7.59	10.88
Per member per 1 000 pages text	7.44	7.36	8.35	8.68	7.39	7.85	6.30	8.19	9.74	15.77
NET COST:										
Total	$1 334.06	$352.82	$98.81	$1 322.90	$1 155.33	$2 091.09	$1 171.98	$694.50	$2 675.04	$1 722.14
Per page	1.65	.54	.17	1.80	1.61	2.70	1.65	1.25	3.68	3.31
Per member	1.82	.47	.13	1.78	1.44	2.32	1.17	.73	2.97	1.95
Per member per 1 000 pages	2.25	.55	.23	2.42	2.00	2.98	1.65	1.31	4.09	3.75
Per member per 1 000 pages text	2.83	.98	.33	2.38	2.55	3.88	2.17	1.83	5.25	5.43

REPORT OF TELLERS.

Whole number of ballots	323
Blank	4

President.

CHARLES W. SHERMAN	315

Vice-Presidents.

FRANK A. BARBOUR	315
PERCY R. SANDERS	315
WILLIAM W. BRUSH	315
REEVES J. NEWSOM	313
PATRICK GEAR	311
GEORGE A. CARPENTER	312
Scattering	3

Secretary.

FRANK J. GIFFORD	316
Scattering	0

Treasurer.

LEWIS M. BANCROFT	317

Editor.

HENRY A. SYMONDS	316
Scattering	1

Advertising Agent.

HENRY A. SYMONDS	315
Scattering	1

Additional Members of Executive Committee.

DAVID A. HEFFERNAN	314
JAMES A. NEWLANDS	315
ARTHUR E. BLACKMER	315
Scattering	1

Finance Committee.

GEORGE H. FINNERAN	312
A. R. HATHAWAY	316
FRANK A. MARSTON	316
Scattering	2

THOMAS E. LALLY,
E. J. LOONEY,
FRED L. CUSHING,
Committee.

FREDERICK W. GOW.

FREDERICK W. GOW, a member of this Association, died July 28, 1920, after more than two months' illness, suffering acutely.

Mr. Gow was the second son of Robert M. Gow, an earlier member of this Association. He was born at Charlestown, Mass., August 15, 1864, going to Medford, Mass., when a small boy, when his father was appointed superintendent of the water works there in 1871. After attending the public schools at Medford he became an engraver. Leaving that occupation he became acting superintendent of the water works with his father.

Upon the death of his father he was made superintendent in 1892, holding the position until May, 1905, when he resigned to associate himself with his brother in the Charles R. Gow Construction Company. With him he had charge of some of the best and largest water-filter plants in the state, as well as working on other water-works problems, doing a general contracting business.

He married, January 17, 1889, Miss Ella F. Davenport, of Medford, Mass., who survives him with three daughters, Miss Miriam Davenport Gow, a teacher of elocution; Miss Ruth Madeline, a teacher in the Norwood High School; Miss Doris Mary, a teacher in the Medford Junior High School; and one son, Frederick William Gow, a student at Tufts Engineering School.

He is survived by two brothers, Robert C., of Cambridge, and Col. Charles R. Gow, the well-known engineer of Boston.

Being brought up in the water works with his father, the superintendent at Medford for twenty-two years, and following him for thirteen years in the same position, his home city felt it must retain his valuable and intimate knowledge if possible, so appointed him a commissioner, a position he held until his resignation in April, 1915, — most of the time as chairman.

He was a devoted member of the Elks, serving in the highest offices of his home lodge, of which he was a charter member, and a lifelong member of the Church of the Immaculate Conception.

The Association loses a valuable and conscientious fellow-member, and will miss his cheery disposition, as his home city and all who came in contact with him do.

Mr. Gow was elected a member of the New England Water Works Association June 13, 1890, a Vice-President 1905–1906, and a member of the finance committee 1914.

FRED L. CUSHING,
ROBERT J. THOMAS,
FRANK E. MERRILL,
Committee.

HARRY H. KINSEY.

Harry H. Kinsey was born in Bristol, Pa., July 10, 1862, and was the son of J. F. and Minnie Thomkins Kinsey. Mr. Kinsey died December 20, 1920, at his home in Allston, Mass.

Divine Providence has called to the Great Beyond our beloved and esteemed friend, Harry H. Kinsey, whose kindly presence and helpful service were ever with us.

Few men had more friends than he. He won them by his fine character, his thoughtfulness of others, his never-failing courtesy, and his acts in life which stamped him as one of Nature's gentlemen.

It seems as though a cloud had suddenly blotted out the sunshine.

For years he had participated in all the activities of this Association, and had rendered useful service in many capacities.

He had a smile for every occasion, and a good word for every one.

To each of us his passing is a personal loss and the cause for genuine sorrow.

He is gone, but the legacy of his life will remain, and will be held in reverent memory by those who knew him and loved him best.

A copy of this Memoir shall be made a part of the minutes of this meeting and shall be laid before the bereaved family of our departed friend, Harry H. Kinsey.

GEORGE CASSELL.
SAMUEL HARRISON.
CHARLES F. GLAVIN.

BOSTON, MASS.,
January 12, 1921.

FRANK J. GIFFORD, *Sec'y*,
715 Tremont Temple, Boston, Mass.

$ .75
Dear Sir: Enclosed please find 1.50 in payment of charge for Certificate
2.25
of Membership in the N. E. W. W. Association ($1.50), and Membership Button ($ .75), which please mail me and oblige

Yours truly,

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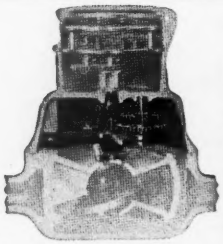
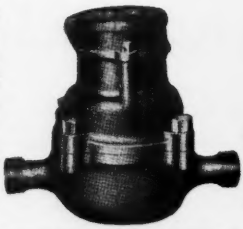


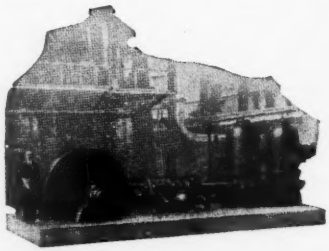
Intermediate Train—Model G. Meter

THE intermediate train consists of three gears and three pinions of equal thickness and diameter, each having the same number of teeth. These parts are all made of Monel metal. Train construction is such that it is absolutely rigid. The removal of three Monel metal screws from the bottom train plate permits of immediate disassembly.



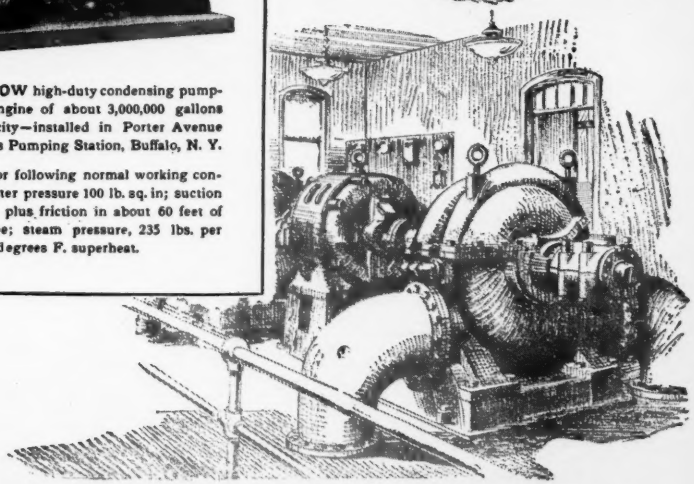
Model "C" Meter

fitted with long main flange bolts and cast iron clamps, is frost proof. Should the meter freeze, the clamp breaks — preventing damage to the interior meter mechanism.



UNAFLOW high-duty condensing pumping engine of about 3,000,000 gallons daily capacity—installed in Porter Avenue Waterworks Pumping Station, Buffalo, N. Y.

Designed for following normal working conditions: Water pressure 100 lb. sq. in; suction lift, 15 feet plus friction in about 60 feet of suction pipe; steam pressure, 235 lbs. per sq. in., 100 degrees F. superheat.



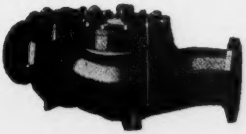
WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works
East Cambridge, Mass.
Worthington Works
Harrison, N. J.
Laidlaw Works, *Cincinnati, Ohio.*

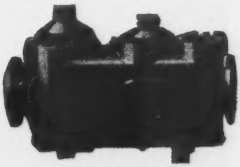
Hazleton Works, *Hazleton, Pa.*

Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works
Cudahy, Wis.
Snow-Holly Works
Buffalo, N. Y.
Epping-Carpenter, *Pittsburgh, Pa.*

Model D
A Worthington flat disc type meter



Turbine
A Worthington current or velocity type meter



Compound
A Worthington combination turbine and disc meter in a single casing

Time-Tested Hydraulic Machinery

IT IS NOT unusual to find in any part of the country old Worthington pumping engines still doing duty after twenty or thirty years service.

Worthington is proud of these rugged old machines—somehow they seem to express the great thought back of the newer Worthington hydraulic equipment.

Compact centrifugal pumping units and high speed unaflow engines may be the expression of advanced engineering—but the proof of the ability to build these machines for lasting service lies in the performance of those older pumps.

WORTHINGTON PUMP AND MACHINERY CORPORATION
***Executive Offices:* 115 Broadway, New York City**
Branch Offices in 24 Large Cities

C6

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works
East Cambridge, Mass.
Worthington Works
Harrison, N. J.
Laidlaw Works, *Cincinnati, Ohio.*
Hanleton Works, *Hazleton, Pa.*
Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works
Cudahy, Wis.
Snow-Holly Works
Buffalo, N. Y.
Epping-Carpenter, *Pittsburgh, Pa.*

The Hersey Disc Meter, Model HF, is the product of thirty-five years of experience and refinement in the manufacture of water meters.

This model in the smaller sizes, together with Model HD in the larger sizes, form a series which excels all meters of all makes in all those essentials which go toward making up an exceptionally desirable meter.

HERSEY MANUFACTURING COMPANY

Main Office and Works: E and 2d Sts., SOUTH BOSTON, MASS.

BRANCHES

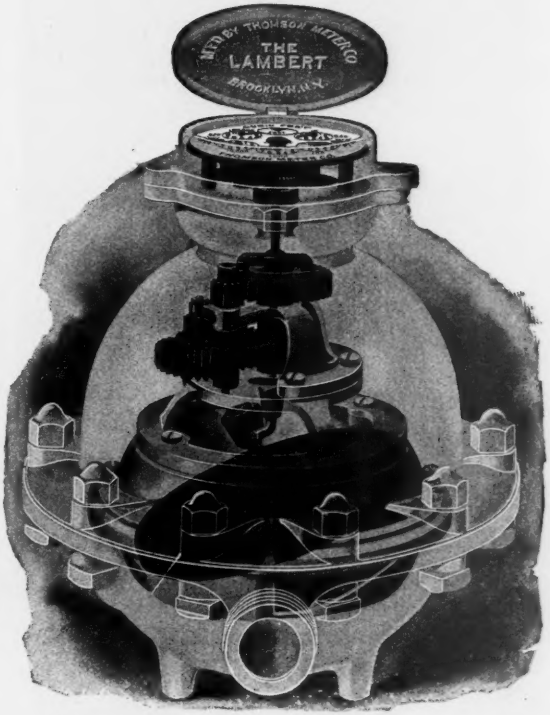
NEW YORK, N. Y. . . . . 290 Broadway
PHILADELPHIA, PA., 132 Commercial Trust Building
COLUMBUS, OHIO . . . 21[illegible] Schultz Building
CHICAGO, ILL. . . . . 10 So. La Salle Street
ATLANTA, GA. . . . . 618 Hurt Building
SAN FRANCISCO, CALIF., 742 Market Street

ACCURACY, LONG LIFE,

Avoidance of Repairs

Are the Requisites of the Perfect Water Meter and are the Principal Features of the

"LAMBERT."

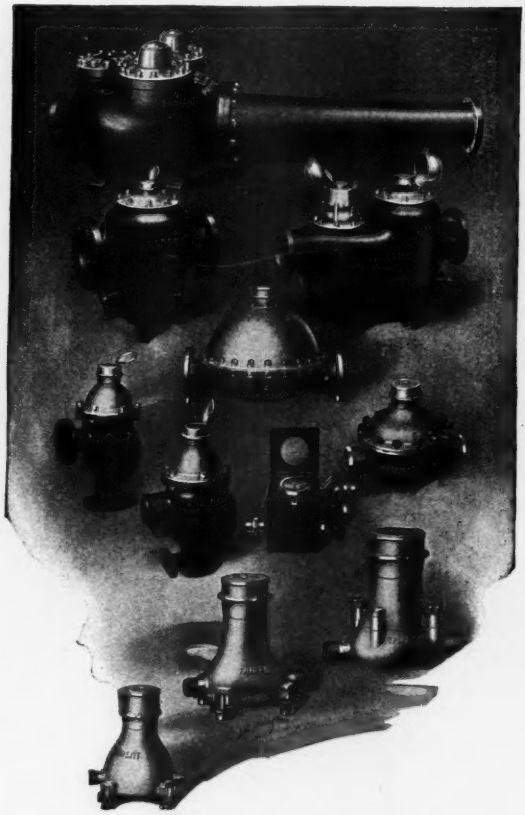


Our unbreakable disk-piston, reinforced with an internal steel plate, can be found only in the **LAMBERT METER.**

The growing popularity of the water-meter system is attributed by many to the inherent excellence of the **"LAMBERT"** meter. Where **"LAMBERT"** meters are selected, success is assured.

THOMSON METER CO.

100-110 BRIDGE ST.
BROOKLYN, N. Y.



A Trident for Every Service!

WHY are there more than a million and a half TRIDENTS in service?

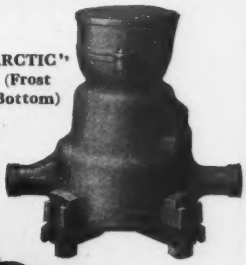
There is only one reason,—TRIDENTS are more continuously accurate, more durable, more economically maintained. They are the *best* meters. Don't stint quality — you need the best for *your* services!

NEPTUNE METER COMPANY

50 EAST 42d ST., NEW YORK CITY

Atlanta **Boston** **Chicago**
Cincinnati **Denver** **Portland**
San Francisco **Los Angeles** **Seattle**

"KEYSTONE"



"ARCTIC" (Frost Bottom)

"EUREKA"

NEW YORK CHICAGO

Keystone and Eureka

Water Meters

COLUMBIA, S.C. KANSAS CITY

Pittsburgh Meter Co.

East Pittsburgh, Pa.

LOS ANGELES SEATTLE

"KEYSTONE-COMPOUND"

"UTILITY"

VENTURI

When Making Changes in Water Works

consider not only the means to **attaining efficiency,** namely the use of high-grade pumping machinery, the construction of water-tight reservoirs, etc. Consider also the means to **maintaining efficiency,** which is fifty per cent. of the problem.

VENTURI METERS

is the answer. They make it possible to determine water supplied, proportion lost before reaching consumer, reserve supply required for drought, leakage, or fire, efficiency of pumps, total water filtered, efficiency of operatives, etc.

Type M Register–Indicator–Recorder

GLOBE SPECIAL CASTINGS

are also made by

Builders Iron Foundry

"Builders of the Venturi"

Providence **Rhode Island**

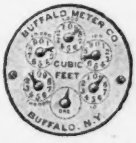
AMERICAN AND NIAGARA WATER METERS

5/8 INCH NEW AMERICAN WATER METER

5/8 INCH NEW NIAGARA WATER METER

Niagara and American Meters are of the disc type. The Niagara Meter has a galvanized cast-iron outside casing; the American Meter has a bronze main casing with either a bronze base or a galvanized cast-iron base. The works in the three different casings are the same and interchangeable. Upon opening the meter at the bolted flange, each intermediate gear may be immediately removed from its bearing, the measuring chamber lifted from its seat, the strainer slipped out, or the register tried by turning the stuffing box gear. All submerged working bearings are protected against sand and sediment. The hard rubber measuring disc is reinforced with a metal plate. Purchaser has option of round reading or straight reading register indicating cubic feet, U. S. gals., imp. gals. or litres.

Round Reading Register



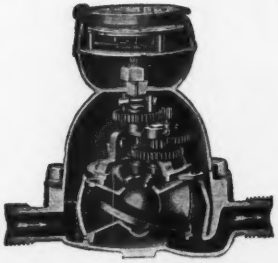
Straight Reading Register

BUFFALO METER CO.

ESTABLISHED 1892

2896 Main Street BUFFALO, N. Y.

UNION WATER METERS



King Model "B" Disc Meter

WATER METERS

cannot be any better than their gear trains, and the life of the gear train is determined by its ability to withstand corrosive conditions.

Hard rubber bushed spindles, intermediate spur gears of hard rubber and phosphor bronze have been a feature of Union Water Meters for forty years. In recent years this has been further perfected by the adoption of Monel Metal for spindles and screws.

The buoyancy of rubber spur gears renders the meter more sensitive and minimizes wear.

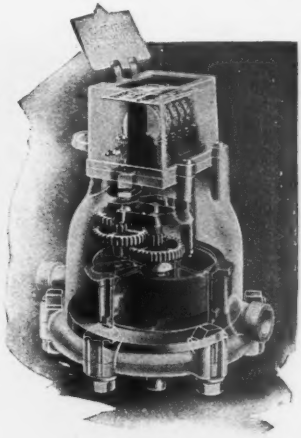
Makers of Approved Water Works Specialties since 1868

Union Water Meter Co.

WORCESTER, MASS.

"THEY SAY"

is not always a remark to inspire confidence, but if "they" make plain statements of plain facts, and all accounts agree, then what "they say" becomes valuable testimony.



Empire Water Meters

are the most sensitive, accurate, durable and long-lived water measuring devices made. This is not offered as our mere unsupported opinion, but is confirmed for your satisfaction by what "they say," quoted below:

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"Since installation we have cut the consumption 40%, and unhesitatingly recommend EMPIRE meters to any Water Corporation."

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"We have about 850 EMPIRES. They give us very little trouble and are very satisfactory."

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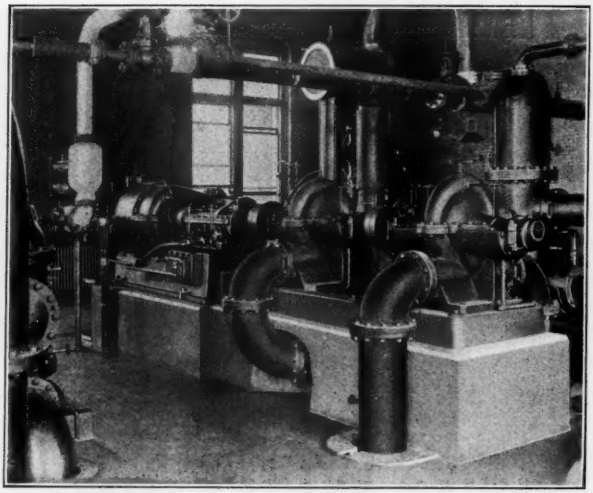

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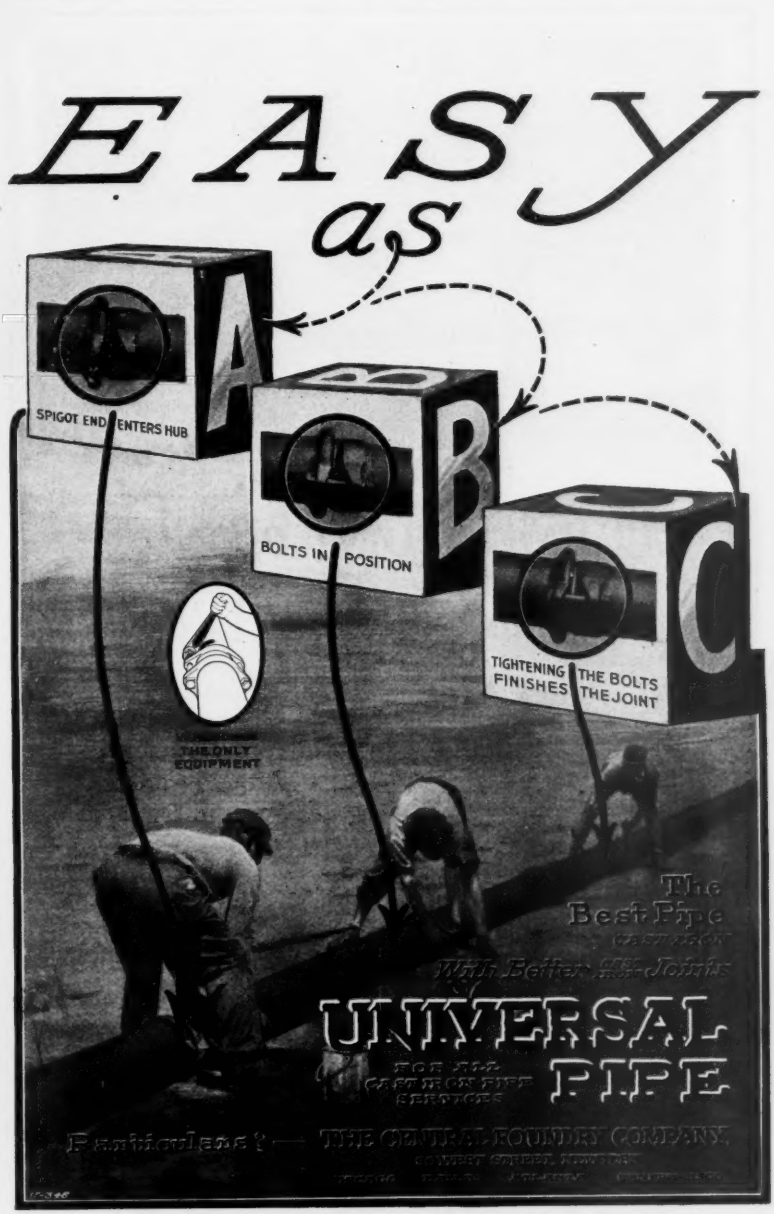
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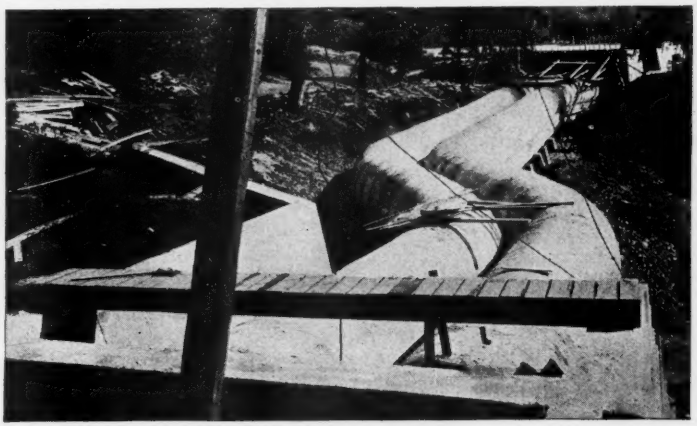

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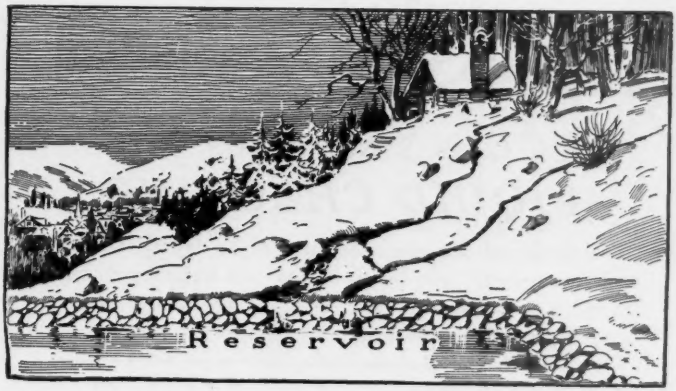

Melting Snow Brought the Scourge of Typhoid

It happened in Plymouth, Pa., and it has happened many times since, and it *may* happen in your town this spring.

Plymouth received her water supply from reservoirs on the surrounding watershed. On this elevation were a few cabins, in one of which was a man suffering from typhoid. The wastes from this cabin were thrown out onto the snow.

And then a few weeks later the snow melted and the refuse was washed down into the reservoirs.

Scarcely a month later an epidemic of over a thousand typhoid cases raged. The cause was directly traceable to the one case on the watershed.

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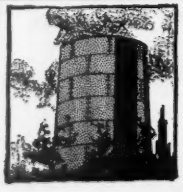
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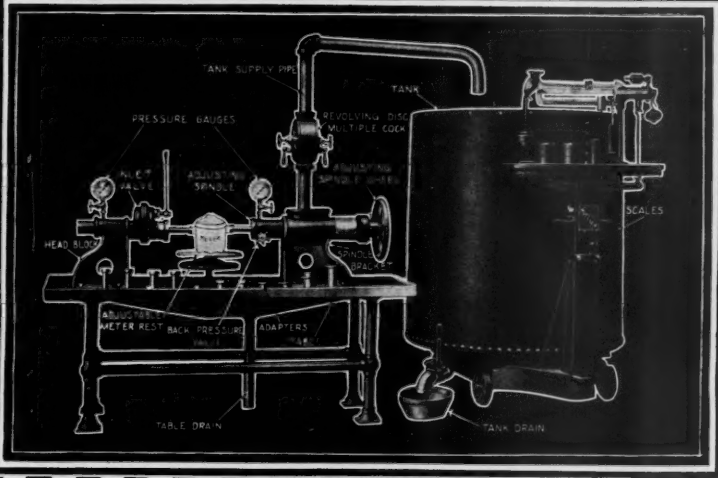

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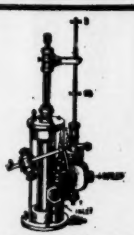

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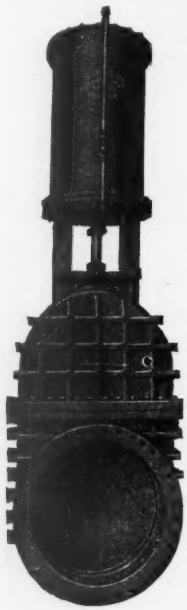

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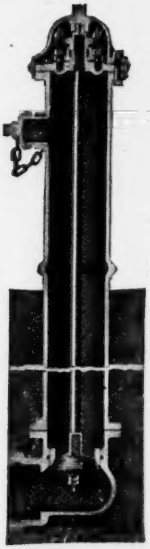

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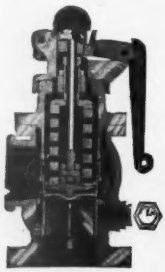

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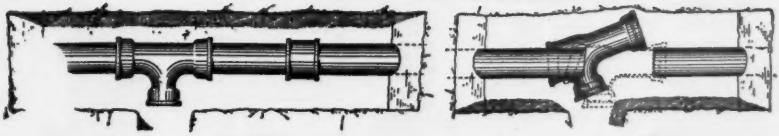

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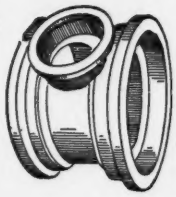

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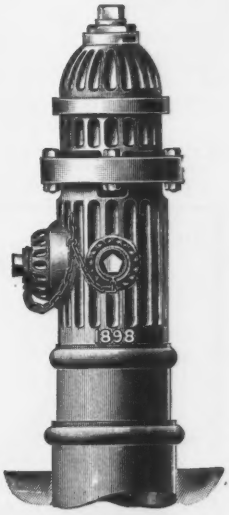

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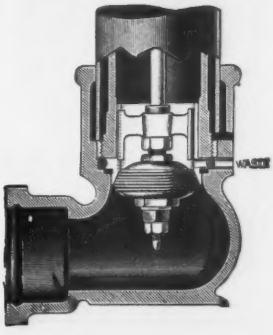

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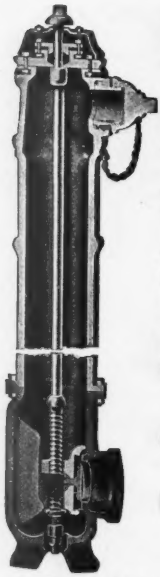

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This hydrant is anti-freezing, because when the drainage is good no water is left in it to freeze.

The drip is directly in the bottom of the hydrant and drains perfectly. It is protected by its valve, which never leaves its socket and cannot be clogged.

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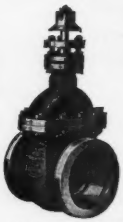

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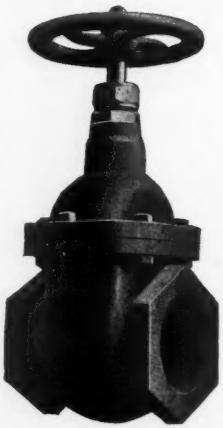

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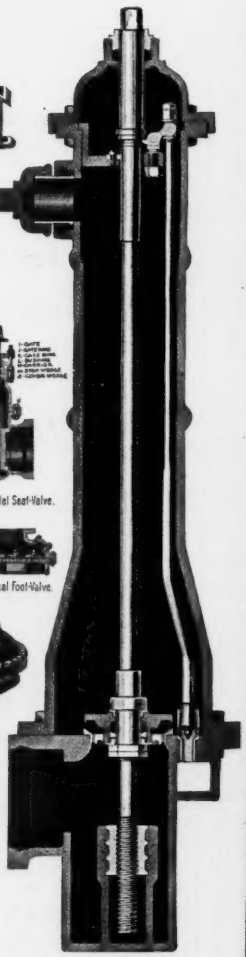
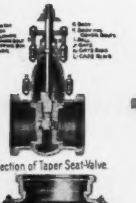
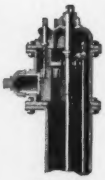
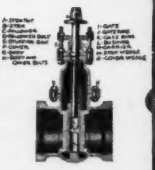




Section of Taper Seat-Valve.



Hydrant with Independent Nozzle Cut-off.



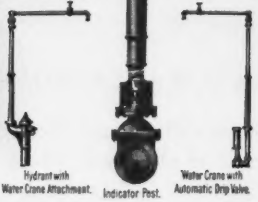
Section of Parallel Seat-Valve.

Section of Vertical Check-Valve.

Section of Vertical Foot-Valve.

Horizontal Check-Valve.

Vertical Foot-Valve.



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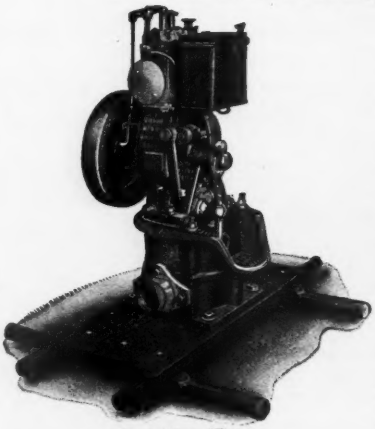

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1. **DURABILITY.** Leadite joints increase in strength with age.
2. **NO CAULKING.** Leadite joints require no caulking, because the Leadite adheres to the pipe, making a water-tight bond.
3. **COMPARATIVE QUANTITIES.** One ton of Leadite is equivalent to four tons of lead.
4. **LABOR SAVING.** Saves caulking charges and digging of large bell-holes, and reduces the cost of trench pumping to the minimum.
5. **COST.** Its use saves 50 to 65 per cent. over lead, owing to the saving effected in material and labor.
6. **TOOLS.** As no caulking is required, fewer tools are needed.
7. **TRANSPORTATION.** Considerable freight charges are saved because Leadite is lighter than lead.
8. **HAULING.** Saves hauling expense on the work because you move only one fourth the weight of jointing material.
9. **FUEL.** Saves fuel because you melt only one ton of material instead of four, and not as much heat is required either.
10. **DELIVERY.** We can make prompt shipments.
11. **DAMAGE SUITS.** Claims for damages caused by joints blowing out are prevented because Leadite joints will not blow out under any pressure.
12. **USERS.** Progressive water works all over the country use Leadite.

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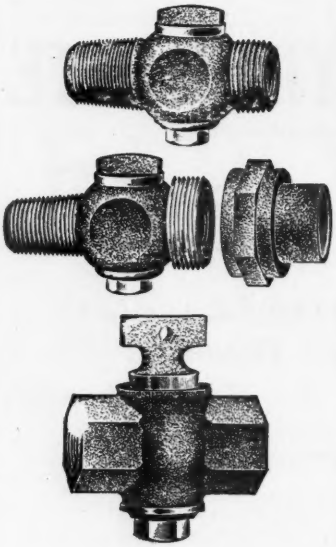

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New England Water Works Association,

ORGANIZED JUNE 12, 1882.

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I, the undersigned, residing at ..... *being desirous of admission into the New England Water Works Association, hereby make application for* .....
(resident, non-resident or associate)
.....*membership.*

I am .....*years of age, and I have been engaged in the following named work:*

.....

.....

.....

I will conform to the requirements of membership if elected.

Signed, ...

Address, ...

Dated, ...*19*

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